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CHAMBERLAIN CREEK ELK-LOGGING STUDY

Progress Report for the 1979 Field Season

School of Forestry

University of Montana

March 30, 1980

Submitted to the

Bureau of Land Management

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CHAMBERLAIN CREEK STUDY

Progress Report for the Period January 1 - December 31, 1979

INTRODUCTION

Generally, the objectives of this study are to describe elk distribution and elk use of several available environmental factors before, during and after logging in Chamberlain Creek in western Montana. The study has been conducted by personnel of the School of Forestry, University of Montana under contract to the Bureau of Land Management since 1975. Additional funding is received from the McIntire-Stennis Federal Forestry Program administered through the Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana.

The contract road on the west side of Chamberlain Creek was completed during 1979. The haul road on the lower east side of Chamberlain Creek was also completed, and Burlington Northern initiated work on a spur road during early fall 1979, which projects south from the haul road into the Drainage. No logging was done within the core study area (CSA) during 1979. The BLM Chamberlain Creek Sale was let in November 1979. Road building will continue during 1980, and logging will be initiated.

Because of a request to reduce the length of the Montana Cooperative Elk-Logging Study annual reports to save on printing costs, we have abbreviated the study area description and methods sections this year. For the same reason, we will primarily present results from data collected during 1979 only. However, the discussion section will consider all results of the study to date. Data collected during previous years of this investigation are presented in the annual report for 1978 (Marcum et al. 1978 and 1979) and in Scott's thesis (1978). Complete descriptions of the study area and methods are also contained in these reports.

STUDY AREALocation and Physiography

The study area is located in the northern Garnet Mountains of western Montana approximately 35 miles (56 km) east of Missoula (Figure 1). Radio-collared elk have used an area of approximately 72 mi² (186 km²). The core study area (CSA), where logging is planned, is 5,800 acres (2,350 ha) in size.

Elevations range from approximately 3,800 feet (1,160 m) along lower Elk Creek to 6,860 feet (2,090 m) at Chamberlain Mountain. Elevations within the CSA range from 4,400 feet (1,340 m) to 6,800 feet (2,070 m).

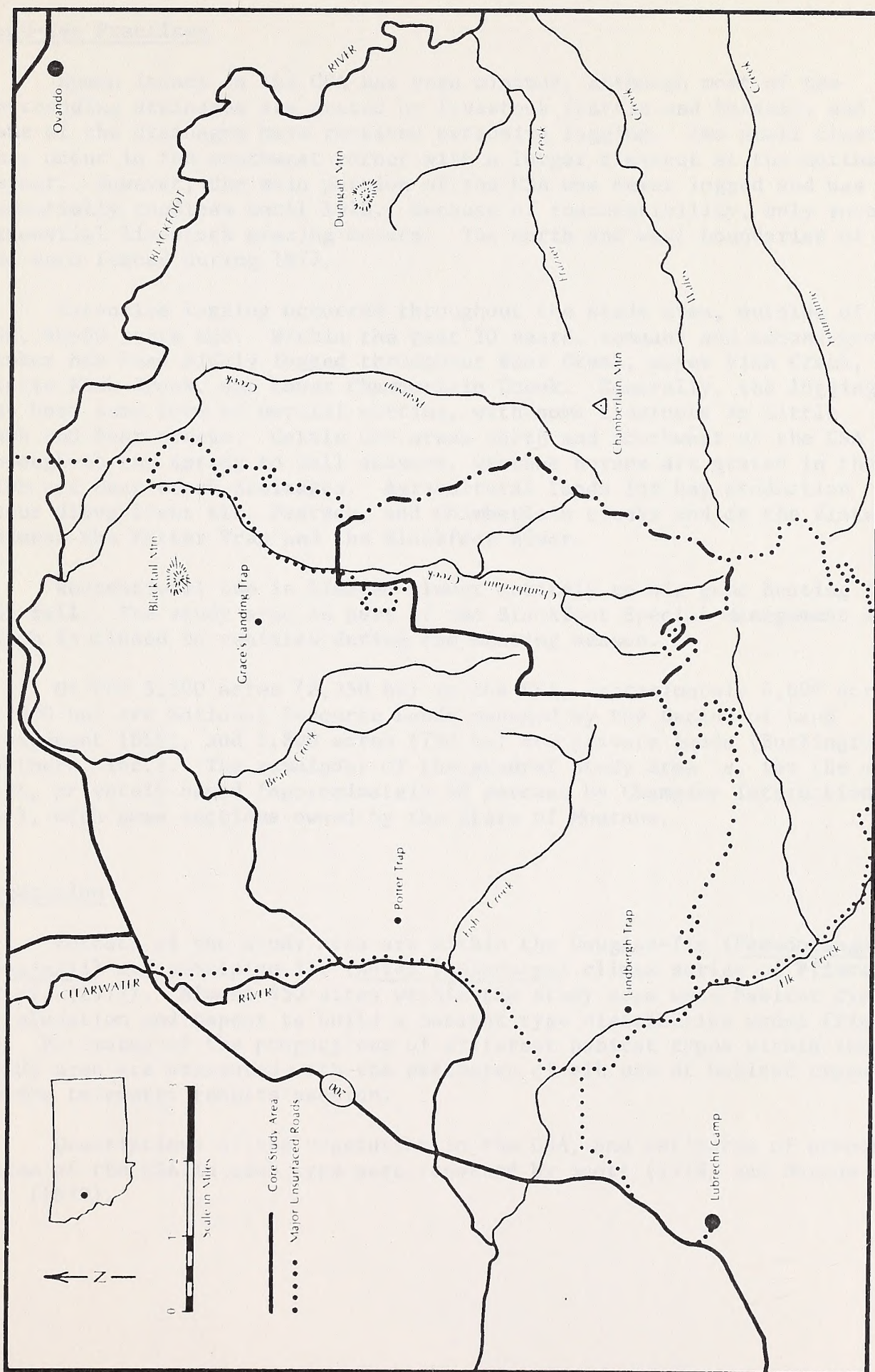


Figure 1. Map of the study area

Land-Use Practices

Human impact on the CSA has been minimal, although most of the surrounding drainages are grazed by livestock (cattle and horses), and some of the drainages have received extensive logging. Two small clearcuts occur in the southwest corner with a larger clearcut at the northwest corner. However, the main portion of the CSA was never logged and was essentially roadless until 1978. Because of inaccessibility, only inconsequential livestock grazing occurs. The north and west boundaries of the CSA were fenced during 1977.

Extensive logging occurred throughout the study area, outside of the CSA, 40-50 years ago. Within the past 20 years, remnant and second-growth timber has been widely logged throughout Bear Creek, upper Fish Creek, Little Fish Creek, and Lower Chamberlain Creek. Generally, the logging has been some form of partial cutting, with some clearcuts in Little Fish and Bear creeks. Cattle use areas north and southwest of the CSA throughout the spring to fall seasons, whereas horses are grazed in the Fish and Bear creek drainages. Agricultural lands for hay production occur along lower Elk, Pearson, and Chamberlain creeks and on the flats between the Potter Trap and the Blackfoot River.

Recreational use is limited almost entirely to big game hunting in the fall. The study area is part of the Blackfoot Special Management Area which is closed to vehicles during the hunting season.

Of the 5,800 acres (2,350 ha) in the CSA, approximately 4,000 acres (1,620 ha) are National Resource Lands managed by the Bureau of Land Management (BLM), and 1,800 acres (730 ha) are private lands (Burlington Northern, Inc.). The remainder of the general study area is, for the most part, privately owned (approximately 80 percent by Champion International Co.), with some sections owned by the State of Montana.

Vegetation

Forests of the study area are within the Douglas-fir (Pseudotsuga menziesii) and subalpine fir (Abies lasiocarpa) climax series of Pfister et al. (1977). Almost 450 sites within the study area were habitat typed by elevation and aspect to build a habitat type distribution model (Figure 2). Estimates of the proportions of different habitat types within the study area are presented with the estimates of elk use of habitat types in the telemetry results section.

Descriptions of the vegetation in the CSA, and estimates of proportions of the CSA in each type were reported by Scott (1978) and Marcum et al. (1979).

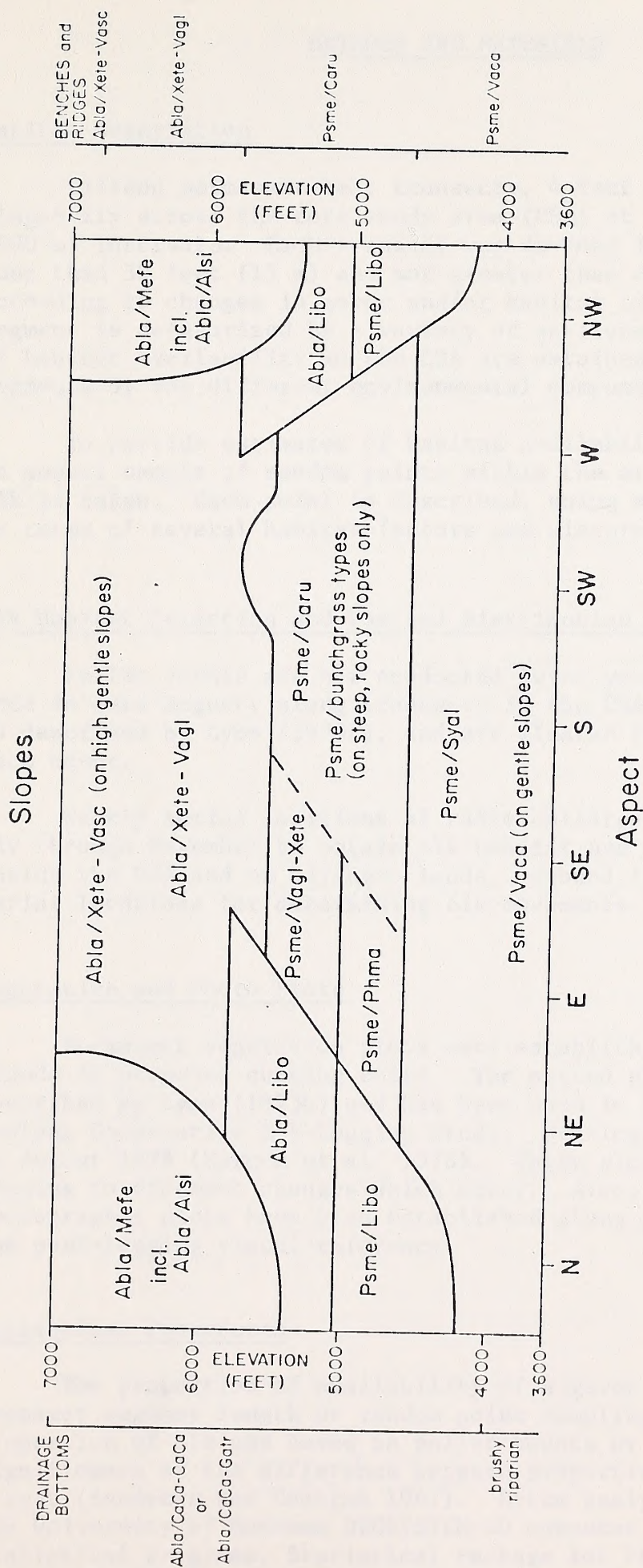


Figure 2. Habitat type distribution model for the entire study area.

METHODS AND MATERIALS

Habitat Description

Fifteen permanent belt transects, 4 feet (1.2 m) wide, were established diagonally across the core study area (CSA) at approximately one-quarter mile (400 m) intervals. Each transect was divided into a series of segments, not less than 50 feet (15 m) and not greater than one-eighth mile (200 m) long, according to changes in cover and/or habitat type (Pfister et al. 1977). Each segment is categorized by a variety of environmental variables. Estimates of habitat availability in the CSA are obtained by summarizing the transect segments by the different environmental components.

To provide estimates of habitat availability for telemetry studies, an annual sample of random points within the area used by radio-collared elk is taken. Each point is described, using maps and aerial photographs, in terms of several habitat factors and disturbance relationships.

Elk Habitat Selection and Use and Distribution and Movements

Pellet counts are now conducted twice yearly, once in late June and once in late August, along transects in the CSA. Pellet groups are aged as described by Lyon (1973a), and are cleared from the transects during each count.

Weekly aerial locations of radio-collared elk are obtained from mid-May through November to obtain elk habitat use and movements data, both inside the CSA and on adjacent lands. Ground telemetry is used to supplement aerial locations for determining elk movements and distribution.

Vegetative and Photo Plots

Permanent vegetation plots were established in eleven representative stands in proposed cutting units. The nested plot sampling system used was described by Lyon (1973b) and has been used in other investigations of the Montana Cooperative Elk-Logging Study. Pre-logging results were reported in August 1978 (Marcum et al. 1978). These plots will be remeasured after logging to document changes which occur. Also, representative permanent photographic plots have been established along pellet transects for pre- and post-logging visual reference.

Statistical Procedures

The proportion of availability of a given habitat factor, based on transect segment length or random point sampling, was compared to the proportion of elk use based on pellet counts or telemetry locations. The significance of the difference between proportions was determined by a Z-test (Snedecor and Cochran 1967). Datum analysis was accomplished using the University of Montana DECSYSTEM-20 computer and a series of standard statistical programs, Statistical Package for the Social Sciences (SPSS, Nie et al. 1975).

The following convention was used to indicate the statistical significance of the difference between the proportion of availability of a habitat factor and the proportion of elk use of that factor: + or - indicates elk use significantly greater or less than availability, $p \leq 0.05$; ++ or -- indicates a significant difference with $p \leq 0.01$; lack of a sign indicates no significant difference.

RESULTS

Pellet and telemetry results are not strictly comparable because of differences in technique, area and time periods considered, and sampling intensity per unit area. Therefore, these results are treated separately.

Pellet Count Results

Transects were cleared of all elk pellets during the last count of 1978. Old and very old (OVO) pellet groups (355) counted during the first count of 1979 provided an estimate of fall 1978 elk use in the CSA. Only fresh and new (FN) pellet groups are used for spring and summer estimates of elk use. Sample sizes for spring counts are 118 during 1979, 82 during 1978, and 139 during 1977. Summer sample sizes are 420 during 1979, 380 during 1978, 600 during 1977, and 201 during 1976.

Because of these substantial differences in sample size between counts, care must be used in interpreting the tabular data which are reported here in terms of proportions of elk use for various environmental categories. Changes in proportions within a category from one count to another do not necessarily reflect changes in the actual number of pellet groups counted for that category.

Elk distribution. The CSA was divided into 11 subunits based on topographic and vegetative homogeneity to identify yearly and seasonal shifts in elk distribution (Figure 3). Table 1 gives percentages of elk use compared to availability for CSA subunits for fall 1978, and spring and summer 1979. Figures 4 through 6 show areas of actual elk use and non-use during the same seasons. Figures 11 and 12 (Appendix I) are composite maps of the consistency of elk use in the CSA for 3 springs and 4 summers.

Elk use in subunits 3, 8, and 9 comprised over one-half the total fall 1978 elk use in the CSA, even though these subunits make up only 39.5% of the area. Use was significantly greater than availability in subunits 3 and 8. Use was less than availability in the other subunits, significantly so in subunit 4. Spring elk use occurred predominantly in the west-facing subunits 8, 9, and 10. Use of other subunits in spring 1979 was less than availability. The greatest summer 1979 elk use was located primarily in subunits 3, 8, 9, 10 and 11, but use was generally well distributed throughout the CSA. Relative elk use during summer months tended to increase in mesic subunits (3, 4, 5, 9, and 11) when compared to relative use in the spring.

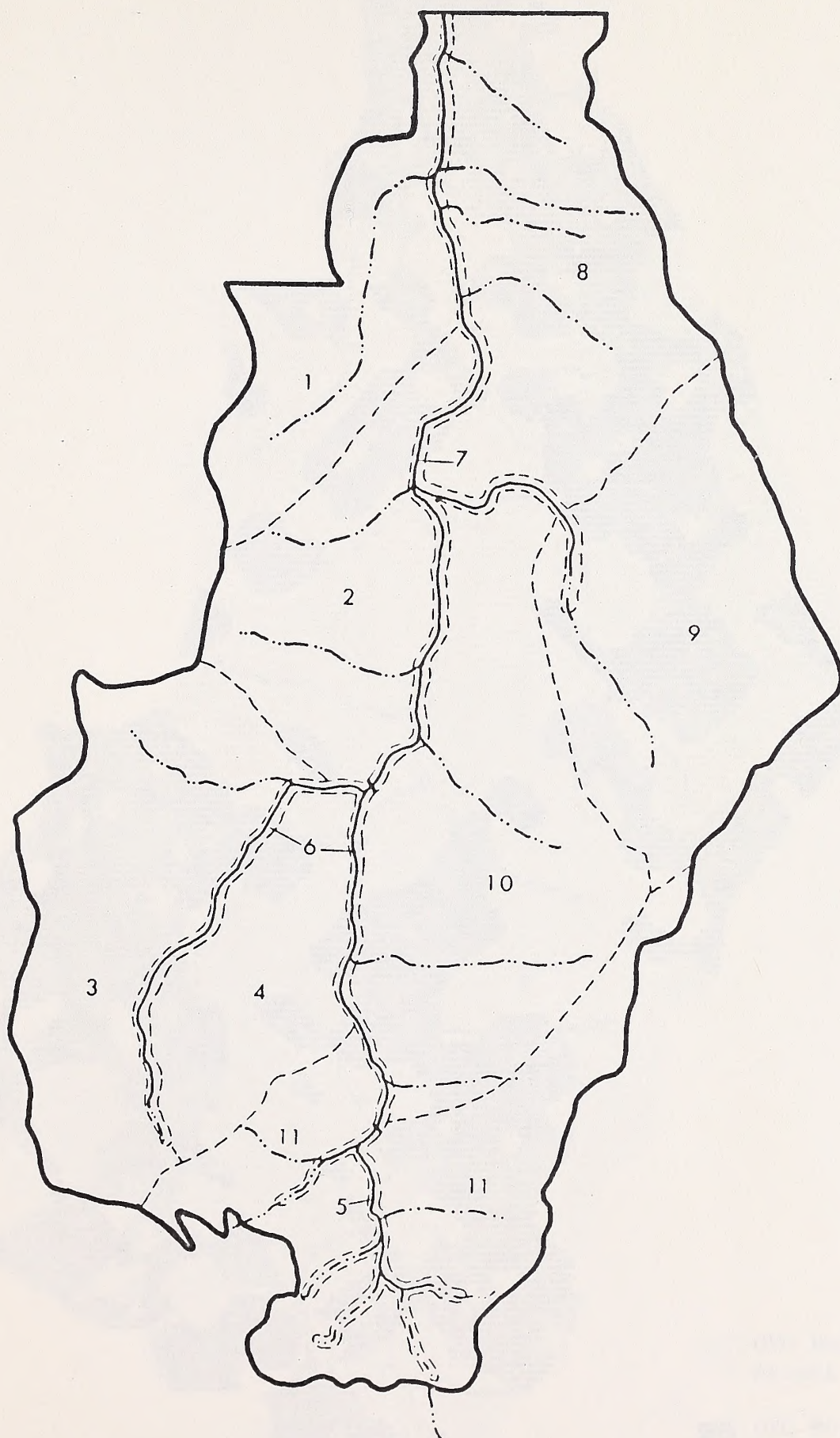


Figure 3. Map of subunits in the core study area.



Figure 4. Areas of elk use and non-use in the CSA during fall 1978.

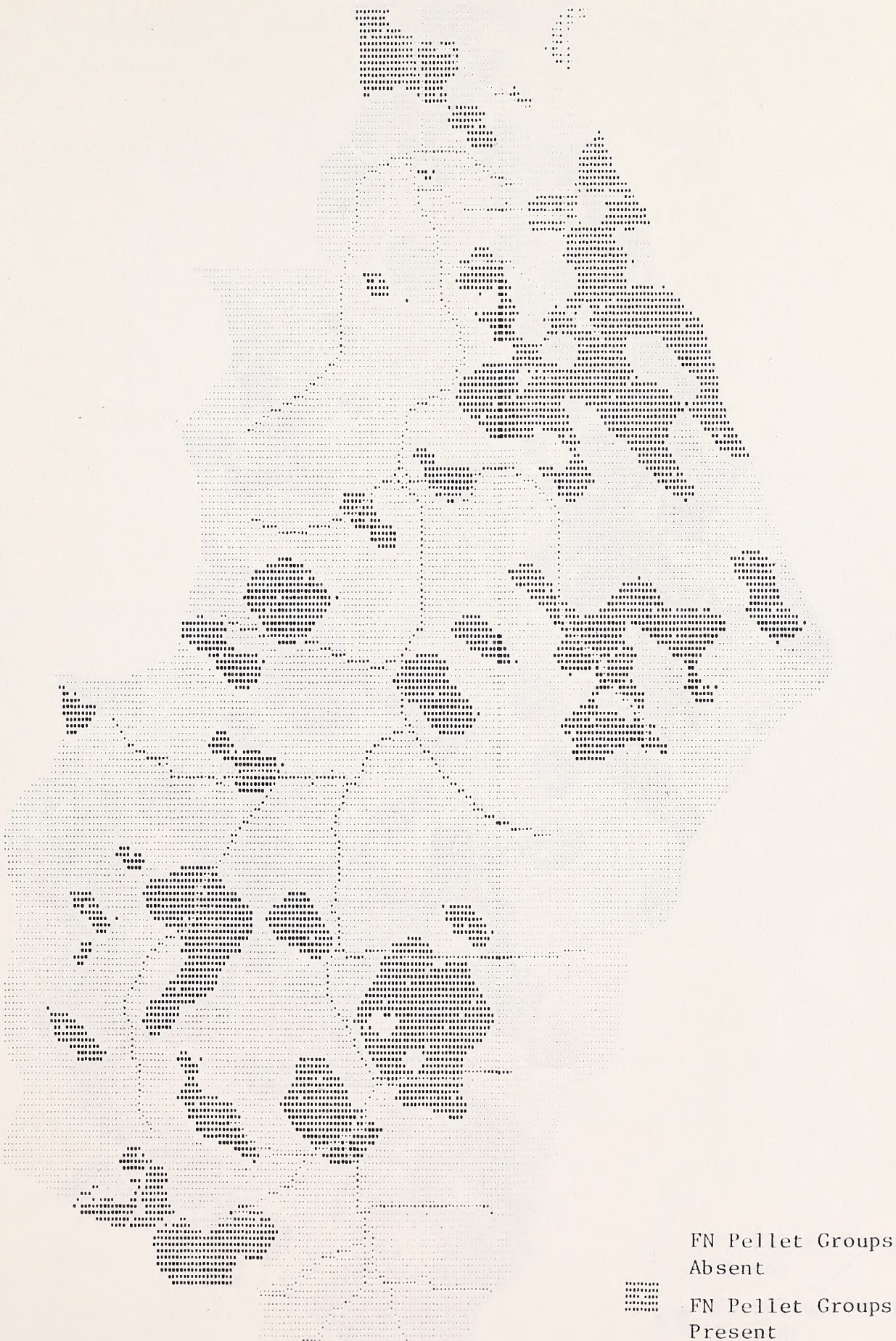


Figure 5. Areas of elk use and non-use in the CSA during spring 1979.

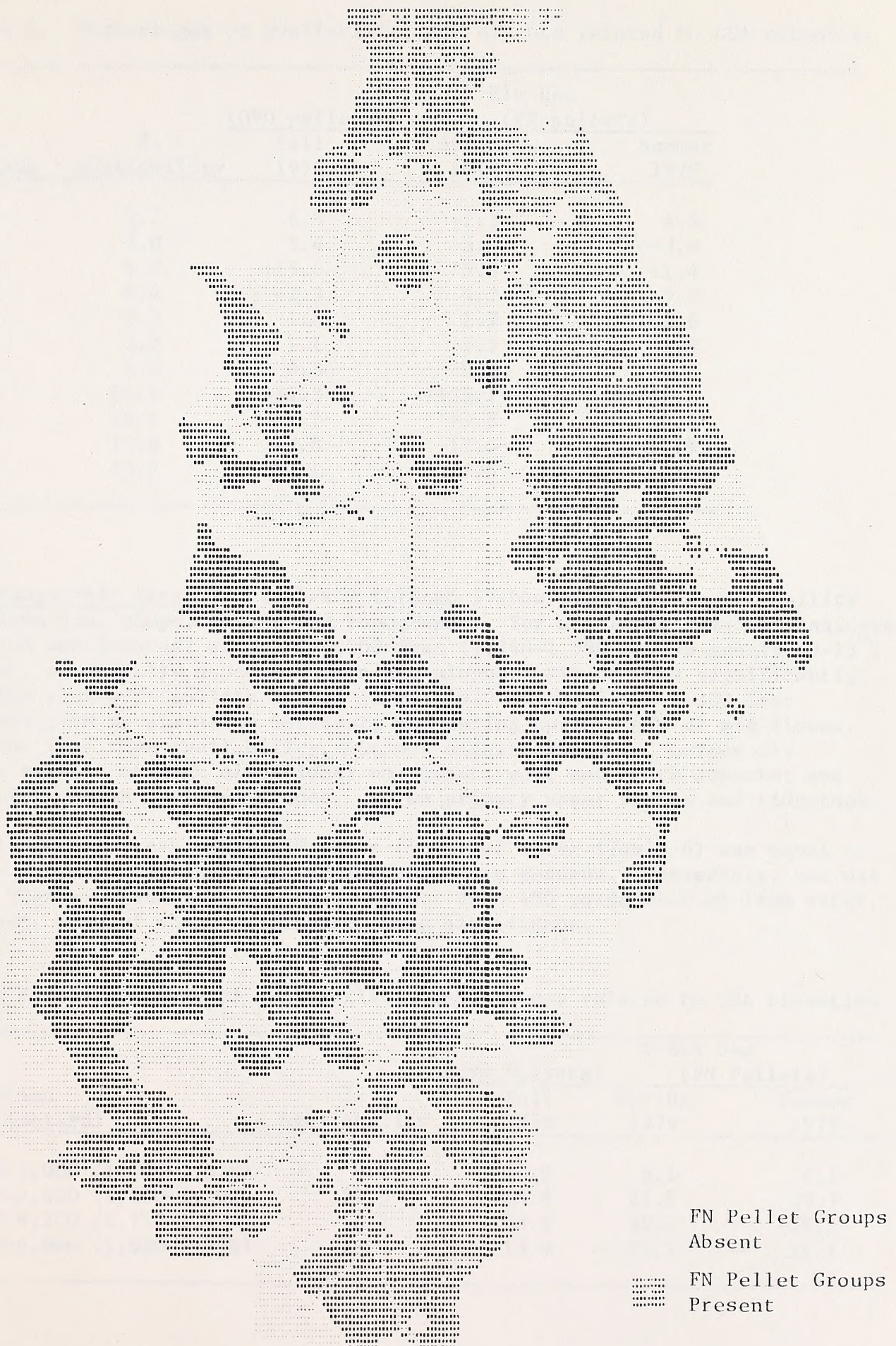


Figure 6. Areas of elk use and non-use in the CSA during summer 1979.

Table 1. Percentages of availability and elk use related to CSA subunits.

Subunit	% Availability	% Elk Use		
		(OVO pellets)	(FN pellets)	
		Fall 1978	Spring 1979	Summer 1979
1	8.7	6.5	-2.5	4.8
2	9.0	5.4	5.1	--3.6
3	9.0	+15.6	5.9	11.4
4	6.4	-2.3	4.2	5.9
5	2.5	1.4	1.7	2.6
6	3.2	1.1	2.5	2.9
7	1.2	0.3	0.0	0.7
8	15.6	+24.3	++35.7	++25.2
9	14.9	17.2	17.8	19.3
10	15.8	13.8	17.0	11.9
11	13.7	12.1	7.6	11.7

Topographic factors. Tables 2 through 5 show elk use and availability by elevation, slope, aspect and topography. For all three seasons considered, elk use was greatest at 5,700-6,200 feet (1,740-1,890 m), on gentle ($0-15^{\circ}$) slopes, on westerly aspects and on mid-slopes. Elk use was significantly greater than availability during summer 1979 at the 5,700-6,200 feet (1,740-1,890 m) elevation interval, and during spring 1979 at mid-slopes. Use was less than availability, but not significantly so, during all three seasons at high elevations; northeast, east and south aspects; and in main streams on lower slopes, and on primary upper slopes and ridgetops.

Elk use of areas within 50 yards (45 m) of water (Table 6) was equal to or in excess of availability during all three seasons. Conversely, use was less than availability for areas greater than 450 yards (410 m) from water. However, none of these differences were significant.

Table 2. Percentages of availability and elk use related to CSA elevation.

Elevation feet (meters)	% Availability	% Elk Use		
		(OVO Pellets)	(FN Pellets)	
		Fall 1978	Spring 1979	Summer 1979
4,500-5,000 (1,370-1,520)	9.1	13.9	5.1	6.1
5,100-5,600 (1,550-1,700)	22.5	18.9	27.1	20.7
5,700-6,200 (1,740-1,890)	50.2	53.3	55.1	+59.1
6,300-6,800 (1,920-2,070)	18.2	13.9	12.7	14.1

Table 3. Percentages of availability and elk use related to CSA slope.

Slope	% Availability	% Elk Use		
		(OVO Pellets)	(FN Pellets)	
		Fall 1978	Spring 1979	Summer 1979
0-15°	65.8	69.0	60.2	68.6
16-30°	30.3	25.5	37.3	29.0
31-38°	3.9	5.5	2.5	2.4

Table 4. Percentages of availability and elk use related to CSA aspect.

Aspect	% Availability	% Elk Use		
		(OVO Pellets)	(FN Pellets)	
		Fall 1978	Spring 1979	Summer 1979
N	9.2	9.0	11.9	10.2
NE	20.5	17.5	12.7	18.6
E	9.7	8.5	5.1	8.1
SE	6.2	7.0	3.4	2.9
S	2.3	1.1	1.7	0.7
SW	15.2	16.4	22.9	18.8
W	16.3	22.4	18.6	16.9
NW	20.6	18.1	23.7	23.8

Table 5. Percentages of availability and elk use related to CSA topography.

Topography	% Availability	% Elk Use		
		(OVO Pellets)	(FN Pellets)	
		Fall 1978	Spring 1979	Summer 1979
Main stream	4.0	2.0	2.5	3.6
Lower slope	6.6	5.4	4.2	6.4
Mid-slope	47.3	51.0	++64.4	51.2
Secondary upper slope and ridgetop	12.7	15.3	10.2	9.3
Primary upper slope and ridgetop	16.1	13.3	8.5	15.2
Bench	5.0	7.1	4.2	6.9
Swale	4.6	4.8	3.4	3.8
Other	3.7	1.1	2.5	3.6

Table 6. Percentages of availability and elk use related to distance to water in the CSA.

Distance to Water yards (meters)	%	% Elk Use		
		(OVO Pellets)	(FN Pellets)	
		Fall 1978	Spring 1979	Summer 1979
0-50 (0-45)	18.3	18.9	23.7	18.3
50-150 (45-140)	23.9	21.5	16.1	22.1
150-250 (140-230)	21.2	28.6	21.2	26.2
250-350 (230-320)	15.3	15.8	17.8	14.3
350-450 (320-410)	11.6	9.3	13.6	11.2
450-850 (410-780)	9.7	5.9	7.6	7.9

Vegetative factors. Elk use and availability percentages for vegetative factors are presented in Tables 7 through 12. During fall 1978, elk primarily used moderately dense stands of lodgepole pine (Pinus contorta). However, use was significantly greater than availability for areas with an open overstory, and with dominant understories of bunchgrass (Festuca idahoensis - Agropyron spicatum) or mountain arnica (Arnica latifolia). Areas with a sight distance of less than 50 yards (46 m), a dense subalpine fir and Englemann spruce (Picea engelmanni) tree stand, a pole-sapling successional stage, and an understory dominated by grouse wortleberry (Vaccinium scoparium) were used significantly less than availability.

Table 7. Percentages of availability and elk use related to CSA overstory canopy cover.

Overstory Canopy Cover	%	% Elk Use		
		(OVO Pellets)	(FN Pellets)	
		Fall 1978	Spring 1979	Summer 1979
0-25%	5.0	49.4	5.1	6.9
25-75%	45.0	42.9	46.6	47.4
> 75%	50.0	47.7	48.3	45.7

Table 8. Percentages of availability and elk use related to CSA sight distance.

Sight Distance yards (meters)	%	% Elk Use		
		(OVO Pellets)	(FN Pellets)	
		Fall 1978	Spring 1979	Summer 1979
< 50 (< 46)	33.1	-25.1	34.7	29.3
50-100 (46-91)	58.3	62.5	48.3	56.9
> 100 (> 91)	8.6	12.4	17.0	+13.8

Table 9. Percentages of availability and elk use related to CSA tree stand type.

Tree Stand Type	% Availability	% Elk Use		
		(OVO Pellets)	(FN Pellets)	
		Fall 1978	Spring 1979	Summer 1979
Dense PSME-LAOC	10.8	11.6	11.9	12.8
Moderate PSME-LAOC	9.9	14.5	8.5	8.3
Scattered large PSME	3.2	5.1	10.2	5.7
Clearing	4.0	7.0	5.1	6.0
Dense ABLA-PIEN	14.8	-8.7	16.1	17.4
Moderate ABLA-PIEN	5.6	5.1	2.5	5.5
Small to medium PICO	8.4	6.2	6.8	-3.6
Medium to large PICO	43.3	41.8	38.9	40.7

PSME = Pseudotsuga menziesiiLAOC = Larix occidentalisABLA = Abies lasiocarpaPIEN = Picea engelmanniPICO = Pinus contorta

Table 10. Percentages of availability and elk use related to CSA successional stage.

Successional Stage	% Availability	% Elk Use		
		(OVO Pellets)	(FN Pellets)	
		Fall 1978	Spring 1979	Summer 1979
Brush-Seedling	1.8	1.7	2.5	3.3
Pole-Sapling	3.3	--0.3	0.0	--0.5
Young Stand	43.5	43.0	44.9	37.6
Mature Stand	27.6	26.8	25.5	27.4
Old Stand	23.8	28.2	27.1	31.2

Table 11. Percentages of availability and elk use related to CSA dominant understory species.

Dominant Understory Species	%	% Elk Use		
		(OVO Pellets)	(FN Pellets)	
		Fall	Spring	Summer
	Availability*	1978	1979	1979
<i>Festuca idahoensis</i> -				
<i>Agropyron spicatum</i>	5.8	+11.8	4.2	4.5
<i>Calamagrostis rubescens</i>	10.1	9.9	18.6	13.1
<i>Arnica cordifolia</i>	6.6	6.2	14.4	10.5
<i>Xerophyllum tenax</i>	35.1	32.4	28.0	27.9
<i>Vaccinium scoparium</i>	17.1	--8.5	5.1	--5.7
<i>Vaccinium globulare</i>	31.9	26.8	27.1	25.2
<i>Menziesia ferruginea</i>	23.1	19.7	20.3	30.2
<i>Alnus sinuata</i>	27.7	30.1	30.5	28.3
<i>Arnica latifolia</i>	11.4	++22.5	14.4	++21.2
<i>Senecio triangularis</i>	5.2	6.8	14.4	8.8
<i>Calamagrostis canadensis</i>	5.0	2.3	4.2	5.0
Other	16.6	15.8	13.6	14.1

*Since the two dominant species on each segment were recorded, the percentages total more than 100 percent.

During spring 1979, elk use of vegetative factors was significantly different from availability in only 2 cases (Table 12). In part, this is a result of relatively small FN pellet group sample size obtained during this season. However, use was markedly greater than availability in two distinctly different types of situations. First, elk sought mature Douglas-fir stands, with long sight distances (> 100 yards, > 91 m), and understories dominated by pinegrass (*Calamagrostis rubescens*) and heartleaf arnica (*Arnica cordifolia*). However, elk also used more mesic areas dominated by relatively dense stands of subalpine fir and lodgepole pine, with understories dominated by mountain arnica, or arrowleaf groundsel (*Senecio triangularis*).

During summer 1979, elk use was significantly greater than availability on areas with long sight distances, and on areas where mountain arnica was the dominant understory plant. Use was also noticeably greater than availability in old timber stands, and in mesic subalpine fir habitat types with understories dominated by fools' huckleberry (*Menziesia ferruginea*) and arrowleaf groundsel. Dense pole-sapling lodgepole pine stands and areas where the understory was dominated by grouse wurtleberry were used significantly less than availability.

Response to disturbance. Disturbance within the CSA was again relatively light during seasons covered by this report. During fall 1978, the secondary haul road between BN cutting units 1 and 3 was constructed (Figure 7), and work continued on the main haul road. Work in both areas ceased on 19 October, just prior to the opening of the general hunting season. During spring and summer 1979, construction of secondary haul roads in and

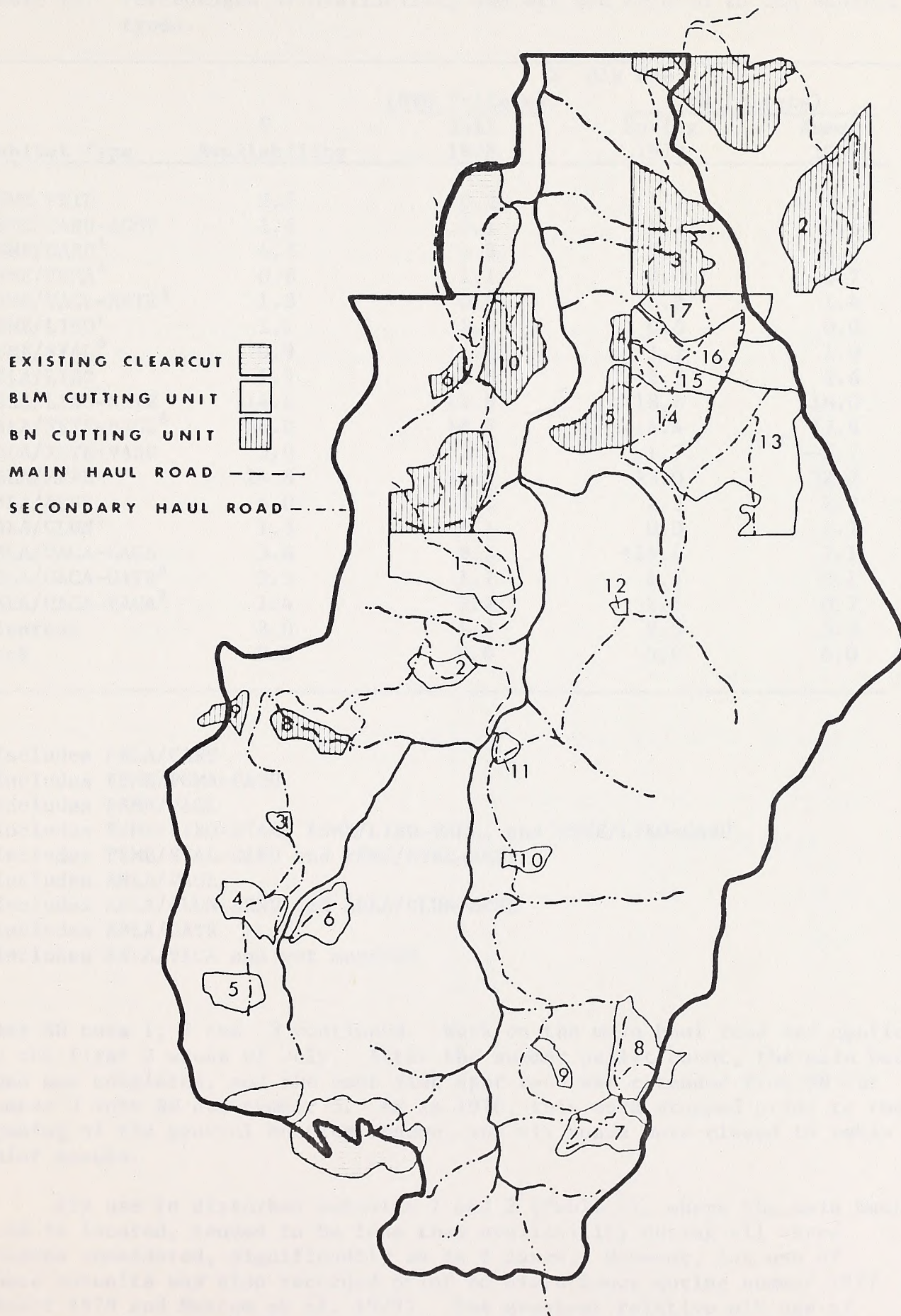


Figure 7. Map of existing clearcuts, planned cutting units, and planned roads in the CSA.

Table 12. Percentages of availability and elk use related to CSA habitat types.

Habitat Type	% Availability	% Elk Use		
		(OVO Pellets)	(FN Pellets)	
		Fall 1978	Spring 1979	Summer 1979
PSME/FEID	2.5	6.2	1.7	1.7
PSME/CARU-AGSP	1.6	5.1	1.7	2.6
PSME/CARU ¹	4.7	4.5	5.1	6.4
PSME/PHMA ²	0.6	1.1	0.0	0.7
PSME/VAGL-XETE ³	1.3	0.6	6.8	1.4
PSME/LIBO ⁴	1.1	1.1	0.0	0.0
PSME/SYAL ⁵	0.9	1.1	1.7	1.0
ABLA/LIBO	1.9	2.8	1.7	2.6
ABLA/LIBO-XETE	14.6	14.8	18.6	16.0
ABLA/XETE-VAGL ⁶	26.0	18.7	-14.4	17.9
ABLA/XETE-VASC	5.0	3.9	1.7	--0.7
ABLA/MEFE	24.8	21.2	23.0	32.2
ABLA/ALSI	4.0	4.8	2.5	2.9
ABLA/CLUN ⁷	1.3	1.1	0.0	0.7
ABLA/CACA-CACA	3.6	8.2	+14.4	7.1
ABLA/CACA-GATR ⁸	2.5	1.7	1.7	2.1
ABLA/CACA-VACA ⁹	1.4	1.4	2.5	0.7
Clearcut	2.0	1.7	2.5	3.3
Rock	0.2	0.0	0.0	0.0

¹Includes ABLA/CARU

²Includes PSME/PHMA-CARU

³Includes PSME/VAGL

⁴Includes PSME/LIBO-SYAL, PSME/LIBO-VAGL, and PSME/LIBO-CARU

⁵Includes PSME/SYAL-CARU and PSME/SYAL-AGSP

⁶Includes ABLA/VAGL

⁷Includes ABLA/CLUN-ARNU and ABLA/CLUN-MEFE

⁸Includes ABLA/GATR

⁹Includes ABLA/VACA and wet meadows

near BN cuts 1, 2 and 3 continued. Work on the main haul road was confined to the first 2 weeks of July. After the summer pellet count, the main haul road was completed, and the east side spur road was extended from BN cut number 3 into BN cut number 5. As in 1978, this work stopped prior to the opening of the general hunting season, and all roads were closed to vehicular access.

Elk use in disturbed subunits 1 and 2 (Table 1), where the main haul road is located, tended to be less than availability during all three seasons considered, significantly so in 2 cases. However, low use of these subunits was also recorded prior to disturbance during summer 1977 (Scott 1978 and Marcum et al. 1979). The greatest relative elk use of subunit 1 was recorded during spring 1978 when road building activities

were most intense. Similarly, road building disturbance occurred mostly in subunit 8 during the seasons reported here, but elk use in this subunit significantly exceeded availability in all 3 cases.

Elk use within 150 yards (140 m) of new CSA roads was significantly less than availability during all 3 seasons (Table 13). Because much of the new road construction is in subunit 8, an area otherwise favored by elk during these seasons, it appears that elk were avoiding this activity. Elk use and availability values as related to distance to proposed roads, and to proposed cutting units in the CSA are given in Tables 14 and 15. No distinct patterns of elk use are evident with respect to either variable.

Table 13. Percentages of availability and elk use related to distance to new roads constructed within the CSA since spring 1978.

Distance Yards (Meters)	% Availability	% Elk Use		
		(OVO Pellets) Fall 1978	(FN Pellets) Spring 1979	Summer 1979
0-150 (0-140)	7.9	-3.4	-2.5	--2.1
150-550 (140-500)	19.8	24.5	26.3	17.9
550-950 (500-870)	16.7	13.0	16.1	20.7
950-1350 (870-1230)	10.4	8.7	18.6	12.4
> 1350 (> 1230)	45.2	50.4	36.5	46.9

Table 14. Percentages of availability and elk use related to distance to proposed roads within the CSA.

Distance Yards (Meters)	% Availability	% Elk Use		
		(OVO Pellets) Fall 1978	(FN Pellets) Spring 1979	Summer 1979
0-150 (0-140)	28.9	29.9	31.4	30.4
150-550 (140-500)	45.4	49.3	49.2	46.4
550-950 (500-870)	18.2	14.9	18.6	19.8
950-1350 (870-1230)	6.3	5.6	--0.8	2.9
> 1350 (> 1230)	1.2	0.3	0.0	0.5

Table 15. Percentages of availability and elk use related to distance to proposed cutting units within the CSA.

Distance Yards (Meters)	% Availability	% Elk Use		
		(OVO Pellets) Fall 1978	(FN Pellets) Spring 1979	Summer 1979
0-150 (0-140)	34.1	38.6	42.4	38.3
150-550 (140-500)	37.5	35.8	35.6	36.0
550-950 (500-870)	19.3	16.9	17.8	19.8
950-1350 (870-1230)	7.5	5.9	4.2	5.2
> 1350 (> 1230)	1.6	2.8	0.0	0.7

Elk distribution in relation to existing clearcuts (and a seed tree cut) and roads in or near the CSA is shown in Tables 16 and 17. These data support the previous conclusion (Scott 1978) that, under relatively low levels of human activity, distributions of elk in the CSA have not been strongly influenced by existing cuts and roads.

Table 16. Percentages of availability and elk use related to distance to existing clearcuts.

Distance to Existing Clearcuts Yards (Meters)	% Availability	% Elk Use		
		(OVO Pellets) Fall 1978	(FN Pellets) Spring 1979	Summer 1979
0-150 (0-140)	6.1	5.4	4.2	5.7
150-550 (140-500)	11.6	11.5	--4.2	9.1
550-950 (500-870)	15.5	21.4	11.0	13.8
950-1350 (870-1230)	15.5	19.7	16.1	15.2
> 1350 (> 1230)	51.3	-42.0	+64.5	56.2

Table 17. Percentages of availability and elk use relating to old roads in the CSA, constructed prior to spring 1978.

Distance to Road Yards (Meters)	% Availability	% Elk Use		
		(OVO Pellets) Fall 1978	(FN Pellets) Spring 1979	Summer 1979
0-150 (0-140)	12.4	8.8	8.5	11.0
150-550 (140-500)	27.4	27.9	27.1	25.7
550-950 (500-870)	27.7	35.2	31.4	34.8
950-1350 (870-1230)	21.6	19.4	28.8	21.4
> 1350 (> 1230)	10.9	8.7	-4.2	7.1

Future cutting units. A summary of pellet groups per 1000 steps within proposed cutting units (Figure 7) is presented in Table 18. BN cutting units were not delineated when the pellet transects were installed, so transects may extend beyond cut boundaries. Thus, results for those units are approximate. Also, four BN units were not sampled. Units 1 and 2 are outside the CSA, and units 4 and 9 are not crossed by a transect. Two other BN units (8 and 10) were only marginally sampled.

Table 18. Pellet groups per 1,000 steps in proposed CSA cutting units.

Cutting Unit		Pellet Groups per 1,000 steps		
		Fall	Spring	Summer
		1978	1979	1979
		OVO	FN	FN
BLM				
	1	0.0	2.3	1.2
	2	3.1	0.0	6.2
	3	20.5	3.4	3.4
	4	4.1	0.8	6.5
	5	0.0	2.8	8.2
	6	7.7	3.9	13.5
	7	6.7	0.0	3.3
	8	2.9	0.0	4.3
	9	0.0	0.0	0.0
	10	3.3	0.0	3.3
	11	0.0	0.0	0.0
	12	0.0	0.0	0.0
	13	4.6	3.4	14.9
	14	8.0	4.0	5.0
	15	2.7	2.7	29.7
	16	0.0	4.3	21.3
	17	6.0	13.1	20.2
BN				
	3	6.8	2.0	6.1
	5	2.2	4.3	4.3
	6	0.0	0.0	0.0
	7	7.0	0.0	0.8
	8	0.0	0.0	0.0
	10	2.2	2.2	0.0
<u>CORE STUDY AREA</u>		4.2	1.4	5.0
<u>ALL CUTS</u>		4.5	2.5	6.6
<u>NON CUT</u>		4.1	1.2	4.7

Elk use of proposed cutting units varies substantially, both seasonally and yearly (Marcum et al. 1979). However, for all three seasons considered in this report, the intensity of use on all proposed cutting units combined was greater than the intensity of elk use of areas which will not be logged.

Elk use in the CSA related to precipitation. Precipitation during 1978-79 was less than normal, and intermediate to that during 1976-77, a drought year, and 1977-78 a more moist year (Figure 8). The summer 1979 pellet count was also intermediate to the 1977 and 1978 counts.

Last year we ran a number of linear regressions using the summer pellet count in the CSA and precipitation, and significant inverse relationships between precipitation and elk use were reported (Marcum et al. 1979). These relationships remain after adding the precipitation and pellet count data for 1979. However, the correlation between yearly precipitation and summer pellet counts on all transects from 1976 through 1979 declined from $r = -0.99$ to $r = -0.95$. When considering pellet counts on only the even numbered transects, we now have 5 years of data. In this case (Figure 9), the correlation between pellet count and precipitation remains very high ($r = -0.99$).

Telemetry Results

A total of 394 aerial locations were obtained for radio-collared elk during 1979. Visual observations were made for 27% of the locations. All of the locations were used to determine elk movements and home range characteristics. Rough approximations, locations that fell far outside the study area, and bull locations were not used for analysis of habitat utilization or to determine relationships to disturbance. Consequently, the sample size for these analyses was lower than the total number of locations (Table 19).

Distribution and movements. Eight adult elk were radio-collared during the winter of 1978-1979: 2 at the Grace's Landing Trap; 4 at the Lindbergh Trap; and 2 at the Potter Trap. All radio-collared elk were females, except for 1 male from the Lindbergh Trap. With the addition of 12 radio-collared elk from previous years, a total of 18 collared elk were present in the study area at the beginning of the field season. Sixteen were females; 2 were males. Fourteen radio-collared elk remained after hunting season. One transmitter package placed on a female was found broken; no signal was received for 1 female after mid-July; 1 bull could not be located after late August; and no signal was received for 1 male after early June. The latter was subsequently killed during the hunting season near Hungry Horse Reservoir, approximately 100 airline miles north of the study area. The transmitter was not working when the animal was killed.

Table 19. Number of aerial locations of radio-collared elk used for habitat utilization and disturbance relationships, and for distribution and movement statistice (in parenthesis) during 1979.

Calving 5-15 to 6-15	Summer 6-16 to 8-31	Rut 9-1 to 10-20	Hunting Season 10-21 to 11-28	Total 5-15 to 11-28
43(52)	164 (175) ^a	91(97)	63(70)	361(394)

^aExcludes 1 location made by chance for elk with failed transmitter.

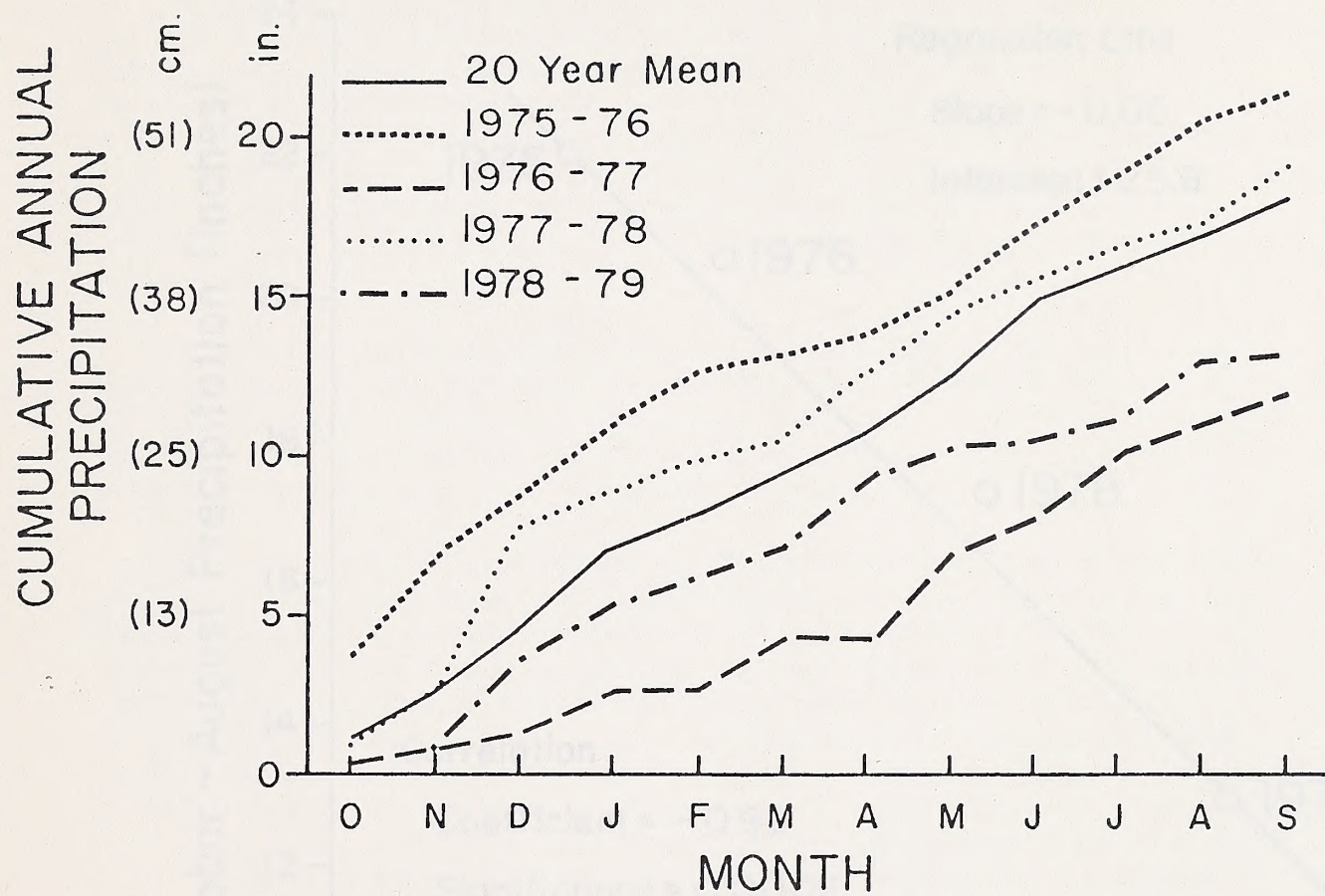


Figure 8. Cumulative annual precipitation at Lubrecht Experimental Forest (Steele 1980).

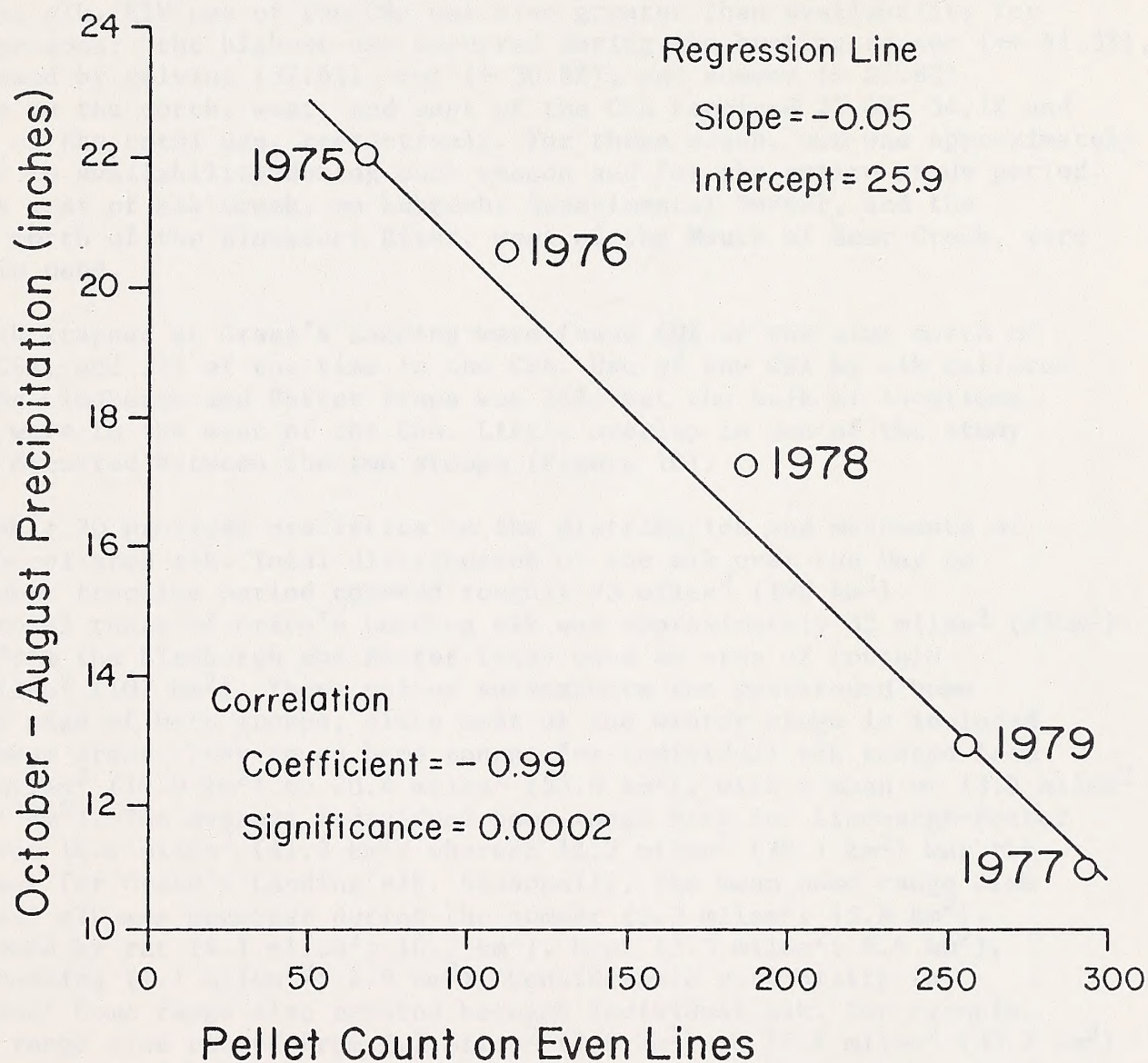


Figure 9. Linear regression of yearly summer pellet counts in the CSA against annual precipitation.

Figures 13 through 20 show polygons which represent areas used by each radio-collared elk. Seasonal and total geographic centers of activity are also shown. (Appendix I)

Total radio-tagged elk use in the CSA was significantly in excess of availability. Thirty-three percent of all locations from May to December were in the CSA, even though it accounts for only 15% of the area used by the elk. Elk use of the CSA was also greater than availability for all seasons: the highest use occurred during the hunting season (41.3%), followed by calving (32.6%), rut (30.8%), and summer (26.8%). Areas to the north, west, and east of the CSA received 27.4%, 34.1% and 5.3% of the total use, respectively. For these areas, use was approximately equal to availability during each season and for the entire study period. Lands west of Elk Creek, on Lubrecht Experimental Forest, and the area north of the Blackfoot River, west of the Mouth of Bear Creek, were little used.

Elk trapped at Grace's Landing were found 60% of the time north of the CSA, and 37% of the time in the CSA. Use of the CSA by elk collared at the Lindbergh and Potter traps was 26%, but the bulk of locations, 57%, were to the west of the CSA. Little overlap in use of the study area occurred between the two groups (Figure 10).

Table 20 provides statistics on the distribution and movements of radio-collared elk. Total distribution of the elk over the May to December tracking period covered roughly 73 miles² (190 km²). The total range of Grace's Landing elk was approximately 32 miles² (83 km²): elk from the Lindbergh and Potter traps used an area of roughly 42 miles² (107 km²). These values approximate the year-round home range size of both groups, since most of the winter range is included in these areas. Year-round home ranges for individual elk ranged from 7.3 miles² (19.0 km²) to 20.4 miles² (53.0 km²), with a mean of 13.9 miles² (36.1 km²). The average individual home range size for Lindbergh-Potter elk was 16.6 miles² (41.9 km²) whereas 11.2 miles² (29.1 km²) was the average for Grace's Landing elk. Seasonally, the mean home range size for all elk was greatest during the summer (5.3 miles²; 13.8 km²), followed by rut (4.1 miles²; 10.7 km²), hunt (3.3 miles²; 8.6 km²), and calving (1.1 miles²; 2.9 km²). Considerable variability in seasonal home range size existed between individual elk. For example, home range size ranged from 2.7 miles² (7.0 km²) to 11.6 miles² (30.2 km²) during the summer. Small sample size for seasonal ranges may be an important factor contributing to the apparent variability.

Although home range size was quite variable, mean distance moved between successive locations exhibited little variability among individual elk or between trap groups. Mean values for the entire season ranged from 1.5 miles (2.4 km) to 2.2 miles (3.5 km), with a grand mean of 1.7 miles (2.7 km). Elk moved an average of 1.4 miles (2.2 km) during calving, 1.6 miles (2.6 km) during the summer, and 1.8 miles (2.9 km) during the rutting and hunting seasons. Between trap groups, the only major difference occurred during the hunting season, when Lindbergh-Potter elk moved an average of 2.1 miles (3.4 km), as opposed to 1.4 miles (2.2 km) moved by Grace's Landing elk.

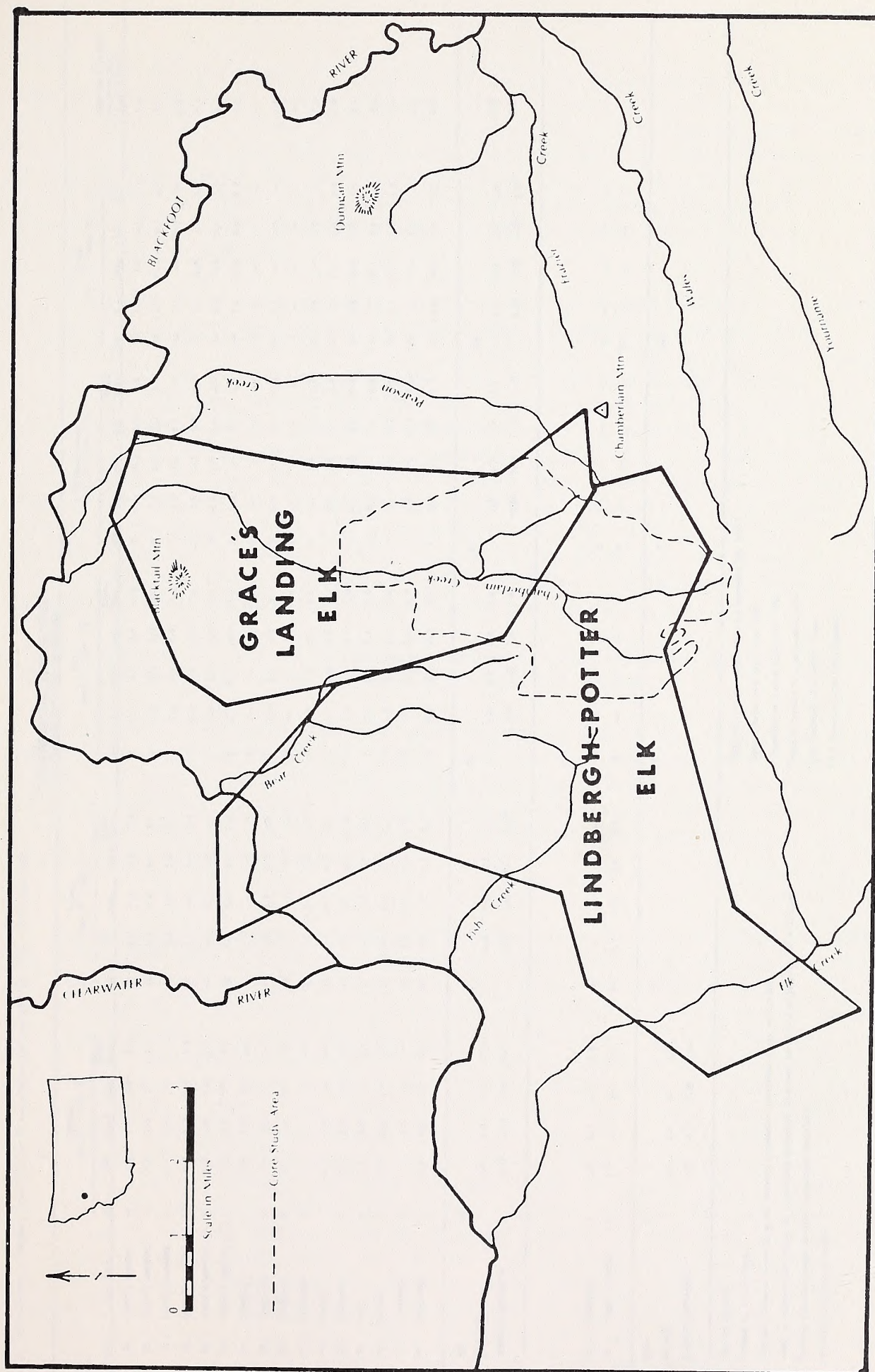


Figure 10. Primary areas used during 1979 by female radio-equipped elk, grouped by trap site.

Table 20. Distribution and movement statistics for 18 radio-tagged elk cracked from 15 May - 28 November 1979.

LOCATIONS AND DISTANCES (AERIAL MILES) SEASONAL AND TOTAL RELATIONS																													
Summer June 16 - Aug. 31													Rut Sept. 1 - Oct. 20				Hunting Season ² Oct. 21 - Nov. 23				Total Nov. 15 - Nov. 28				Maximum Distance Between any 2 Locations				
Females Elk No.	Age ¹	Trap Site	No. ³	\bar{X}	Area ⁴	Max. ⁵	Stam. Dis.	No.	\bar{X}	Area	Max.	Stam. Dis.	No.	\bar{X}	Area	Max.	Stam. Dis.	No.	\bar{X}	Area	Max.	Stam. Dis.	No.	\bar{X}		Area	Max.	Stam. Dis.	
22	2½	Grace's Landing	4	1.3	1.7	1.8	2.7	11	2.2	6.6	4.6	3.8	7	1.2	1.4	2.4	1.9	5	1.6	1.3	2.0	2.2	27	1.7	7.9	4.6	3.3	5.4	
35	3½	Grace's Landing	4	1.4	1.5	2.1	1.9	10	1.3	3.8	3.2	2.4	7	1.6	3.3	2.8	2.9	5	1.2	0.5	2.2	1.7	26	1.7	15.4	6.7	4.9	8.3	
37	2½	Grace's Landing	1	--	--	--	--	11	1.3	3.0	2.4	2.1	7	2.1	1.1	3.9	3.7	5	1.3	1.0	1.6	1.7	24	1.5	--	3.9	--	5.6	
42	2½	Grace's Landing	4	0.7	0.3	0.9	0.8	11	1.7	4.2	3.4	2.8	7	2.1	5.3	3.6	3.2	5	2.4	2.2	3.7	4.7	27	1.7	10.6	3.7	3.7	6.1	
23	2½	Grace's Landing	4	1.3	0.6	2.4	2.3	10	1.4	3.7	3.7	3.0	7	1.5	4.6	3.9	4.1	5	0.8	0.2	1.2	0.9	26	1.5	7.3	5.4	3.7	6.1	
411	5½	Grace's Landing	4	1.1	0.7	2.7	2.5	10	1.2	3.5	2.5	2.1	7	2.1	11.1	6.0	5.0	5	1.1	1.4	2.3	1.9	26	1.6	14.9	6.0	4.0	6.1	
23*	1½	Lindbergh	4	1.0	0.7	2.2	1.9	6	1.7	--	--	--	--	0	--	--	--	--	0	--	--	--	--	10	--	--	--	--	--
28	2½	Lindbergh	0	--	--	--	--	11	1.2	3.9	2.5	2.0	7	1.9	2.4	4.5	3.2	5	1.9	6.5	3.0	4.3	23	1.7	--	4.5	--	7.0	
292*	2½	Lindbergh	2	2.2	--	2.2	2.2	7	--	--	--	--	--	0	--	--	--	--	0	--	--	--	--	9	--	--	--	--	--
211	4½	Lindbergh	0	--	--	--	--	11	2.2	6.5	3.8	4.3	7	1.6	1.2	2.4	1.9	5	1.4	0.9	3.4	2.6	23	1.8	--	3.8	--	7.1	
31	4½	Potter	4	2.8	4.1	3.4	3.1	11	2.4	9.1	4.9	3.1	7	1.5	6.8	2.9	4.3	5	2.5	7.9	3.1	3.6	27	2.2	19.4	4.9	3.9	6.9	
33	2½	Lindbergh	4	1.6	1.9	2.2	2.4	12	1.5	5.2	3.5	2.8	7	1.7	3.6	4.5	3.9	5	2.7	6.8	3.9	3.9	28	1.8	16.9	4.5	3.4	6.4	
34	3½	Potter	4	1.2	0.6	1.7	1.8	11	1.7	5.8	3.2	3.5	7	2.0	4.2	6.6	5.1	5	1.5	1.1	2.2	2.2	27	1.7	11.1	6.6	4.2	7.9	
39	4½	Potter	3	1.4	0.4	2.4	2.3	11	1.6	4.1	4.0	2.1	7	2.3	9.4	4.3	4.4	5	2.4	5.1	3.7	3.5	26	2.1	15.2	5.7	3.9	7.0	
312	2½	Lindbergh	0	--	--	--	--	11	1.8	11.6	4.1	4.8	7	1.6	1.7	5.9	4.0	5	1.8	6.6	3.0	4.5	23	1.6	--	5.9	--	6.5	
41	6½	Lindbergh	3	1.0	0.0	1.9	1.8	10	1.2	2.7	3.7	2.7	6	1.0	1.2	1.7	2.4	5	2.2	4.3	5.8	4.9	24	1.6	20.4	5.9	5.3	8.1	
<hr/>																													
SUM			45					164	1.6	5.3	3.5	3.0	97	1.8	4.1	4.0	3.6	70	1.8	3.3	2.9	3.1	376						
AVERAGE ¹¹				1.4	1.1	2.2	2.1																	1.7	13.9	5.2	4.0	6.8	
STANDARD DEVIATION				0.57	1.15	0.60	0.57		0.40	2.51	0.75	0.87		0.31	3.15	1.47	1.03		0.59	2.79	1.17	1.32		0.20	4.53	1.02	0.63	0.90	
<hr/>																													
Males Elk No.																													
36 ¹¹	1½	Lindbergh	3	1.8	0.7	2.1	1.9	1	--	--	--	--	--	0	--	--	--	--	0	--	--	--	--	4	--	--	--	--	--
49 ¹²	1½	Grace's Landing	4	1.6	1.7	3.2	3.3	10	1.1	3.0	2.6	3.3	0	--	--	--	--	0	--	--	--	--	14	--	--	--	--	--	--
<hr/>																													
SUM			7					11					0					0					18						
AVERAGE				1.7	1.2	2.7	2.6																						
STANDARD DEVIATION				0.14	0.71	0.78	0.99																						

¹Age at capture.²Number of relocations.³Average distance moved in miles between successive locations (1 mi. = 1.6 km).⁴Area in square miles based on connecting perimeter locations to form a polygon (1 mi² = 2.6 km²).⁵Maximum distance moved between successive locations.⁶Standard diameter in miles.⁷Includes 16 locations taken on November 28, 1979.⁸Collar broke off late July 1978.⁹Transmitter failed late July 1978.¹⁰Mean of values for individual elk.¹¹Not located after early June.¹²Not located after late August.

Values for maximum distance moved between successive locations for the May to December period ranged from 3.7 miles (5.9 km) to 6.7 miles (10.7 km), with a mean of 5.2 miles (8.3 km). The highest mean value was recorded for the rutting season (4.0 miles; 6.6 km), followed by summer (3.5 miles; 5.6 km), hunt (2.9 miles; 4.6 km), and calving (2.2 miles; 3.5 km). The greatest variability among individual elk occurred during the hunting season when the range was 1.2 miles (1.9 km) to 5.8 miles (9.3 km).

Standard diameters (Lonner 1976, after Harrison 1958) for radio-collared elk are also given in Table 20. Standard diameters for individual elk ranged from 3.3 miles (5.3 km) to 5.3 miles (8.5 km), with a mean of 4.9 miles (7.8 km), for the entire study period. Individual values varied little from the mean. Seasonally, the mean standard diameter was lowest during the calving period (2.1 miles; 3.4 km). It increased during the summer (3.0 miles; 4.8 km) and peaked during the rut (3.6 miles; 5.8 km), then decreased during the hunting season to equal that of summer. The greatest variability in standard diameter for individual elk occurred during the hunting season: values ranged from 0.9 miles (1.4 km) to 4.9 miles (7.8 km). In general, elk trapped at the Lindbergh and Potter traps had larger standard diameters than those elk trapped at Grace's Landing.

Twenty-one of the 54 seasonal activity centers fell within the CSA; 6 of 14 total activity centers occurred there.

Statistics for male elk are also shown in Table 20. Comparisons of statistics between male and female elk are tenuous due to the small number of locations for males. Hopefully, more males will be radio-collared and successfully tracked in the future so that more information concerning their distribution and movements will be available for reliable comparisons with female elk.

Topographic factors. Within an elevational range of 3,800 -6,800 feet (1,160-2,070 m), the great majority of radio-collared elk were located at elevations from 4,500-6,200 feet (1,370-1,890 m) (Table 21). Although total use was somewhat evenly distributed within this range, elk significantly preferred the 5,100-6,200 feet (1,550-1,890 m) interval. During the calving period, the percentage of locations was greatest in areas from 5,100-5,600 feet (1,550-1,700 m), and use was significantly greater than availability. By summer, elk were found within a broader range of elevations (4,500-6,200 feet; 1,370-1,890 m), but they significantly preferred areas between 5,100 and 6,200 feet (1,550-1,770 m). Except for a decrease in use of moderately low elevations (4,500-5,000 feet; 1,370-1,520 m), the pattern of use did not change appreciably during the rut, from that of summer. A decrease in use of elevations below 5,600 feet (1,700 m) was noted during the hunting season, but areas from 5,700 to 6,200 feet (1,740-1,890 m) continued to be significantly preferred. The greatest use of elevations above 6,200 feet (1,890 m) was noted at this time. Areas below 4,400 feet (1,340 m) were consistently used significantly less than their availability.

Table 21. Percentages of availability and elk use related to study area elevation, 1979.

Elevation feet (meters) N	%	% Elk Use				
		Availability	Calving	Summer	Rut	Hunt
		400	43	164	91	63
3,800-4,400 (1,160-1,340)	40.8	--4.7	--6.7	--11.0	--4.8	--7.2
4,500-5,000 (1,370-1,520)	25.0	25.6	30.5	17.6	14.3	23.8
5,100-5,600 (1,550-1,700)	14.5	++41.9	++28.7	+28.6	23.8	++29.4
5,700-6,200 (1,740-1,890)	15.0	25.6	++31.1	++35.2	++41.3	++33.2
6,300-6,800 (1,920-2,070)	4.8	2.3	3.0	7.7	+15.9	6.4

With respect to steepness of slope, elk preferred gentle ($0-15^{\circ}$) slopes, particularly during the hunting season (Table 22). Use of slopes steeper than 15° was for the most part less than availability, but was significantly less than availability during the hunting season.

Table 22. Percentages of availability and elk use related to study area slope, 1979.

Slope N	%	% Elk Use				
		Availability	Calving	Summer	Rut	Hunt
		400	43	164	91	63
0- 15°	59.0	62.8	67.1	65.9	++84.1	++69.3
16- 30°	34.0	27.9	27.4	30.8	--15.9	-26.3
> 30°	7.0	9.3	5.5	3.3	--0.0	4.4

Radioed elk generally showed little preference for aspect (Table 23). West, northwest, northeast, and east aspects were utilized the most, but only on the latter two did use significantly exceed availability for all locations. Level areas were significantly underutilized except during the rut. Use was significantly low on southwest slopes as well.

Upper slopes were preferred during every season (Table 24), significantly so except for the calving season. Conversely, lower slopes, drainage bottoms, and drainage heads were used significantly less than their occurrence. Total use of ridgetops significantly exceeded availability, and a marked preference was noted during the calving season. Along with upper slopes, mid-slope areas were significantly preferred during the summer. A finer breakdown of elk use in relation to slope position indicated that upper slopes of secondary ridges were selected for during the rut and for the entire season; whereas upper slopes of primary ridges were used about equal to their availability, except during the hunting season when use significantly exceeded availability.

Table 23. Percentages of availability and elk use related to study area aspect, 1979.

Aspect	%	% Elk Use				Total
	Availability	Calving	Summer	Rut	Hunt	
N	400	43	164	91	63	361
N	16.8	18.6	--7.3	9.9	11.1	10.0
NE	9.5	16.3	16.5	14.3	19.0	+16.3
E	7.5	14.0	14.0	17.6	9.5	+14.1
SE	4.8	4.7	8.5	8.8	1.6	6.9
S	2.8	2.3	5.5	--0.0	3.2	3.3
SW	9.8	2.3	5.5	--1.1	3.2	--3.6
W	13.5	20.9	12.8	13.2	19.0	15.0
NW	15.8	16.3	18.9	12.1	25.4	18.0
Level	19.8	--4.7	-11.0	23.1	-7.9	-12.7

Table 24. Percentages of availability and elk use related to study area slope position, 1979.

Slope Position	%	% Elk Use				Total
	Availability	Calving	Summer	Rut	Hunt	
N		43	164	91	63	361
Ridge Top	8.8	25.6	10.4	17.6	17.5	+15.2
Upper Slope	25.0	39.5	+37.2	++42.9	++52.4	++41.6
Mid-Slope	21.8	25.6	++40.2	22.0	17.5	29.9
Lower Slope	31.3	--7.0	--9.8	--15.4	--12.7	--11.4
Drainage Bottom	8.8	2.3	--1.2	--2.2	--0.0	--1.4
Drainage Head	4.5	--0.0	1.2	--0.0	--0.0	--0.6

With respect to horizontal configuration of the slope along the contour, straight and concave configurations were generally favored (Table 25). Convex configurations were preferred during the calving period, but were used significantly less than availability during the rutting and hunting seasons, and for the entire period. Straight and concave configurations were generally selected for during the summer and rut, but not significantly so. During the hunting season, straight configurations received the most use, followed by convex configurations.

Elk appeared to be little affected by the distribution of water and moist sites in the study area during 1979 (Table 26). Use of areas greater than 550 yards (500 m) from moist sites was significantly greater than availability from May to December; whereas areas within 150 yards (140 m) of water were generally used less than availability, except during summer when use approximately equalled availability.

Table 25. Percentages of availability and elk use related to horizontal configuration along the slope contour, 1979.

Horizontal Configuration	Availability N	400	% Elk Use				Total 361
			Calving 43	Summer 164	Rut 91	Hunt 63	
Convex		30.5	41.9	-20.1	--12.1	31.7	-22.7
Straight		35.0	25.6	37.2	39.6	46.0	38.0
Concave		26.0	23.3	+36.0	37.4	20.6	32.1
Undulating		8.5	9.3	6.7	11.0	--1.6	7.2

Table 26. Percentages of availability and elk use related to distance to water, 1979.

Distance to Water yards (meters)	Availability N	400	% Elk Use				Total 361
			Calving 43	Summer 164	Rut 91	Hunt 63	
0-50 (0-45)		16.0	-4.7	15.9	14.3	--3.2	11.9
50-150(45-140)		23.0	--7.0	20.7	-11.0	--3.2	--13.6
150-250(140-230)		24.0	27.9	24.4	--9.9	22.2	20.8
250-350(230-320)		15.5	16.3	14.6	+29.7	31.7	21.6
350-450(320-410)		12.5	20.9	13.4	18.7	19.0	16.6
450-550(410-500)		5.3	11.6	3.7	7.7	3.2	5.5
>550 (>500)		3.8	11.6	7.3	8.8	+17.5	++10.0

Vegetative factors. Dense and closed canopy coverage classes were used by elk in excess of their availability during all seasons (Table 27). Total use in both classes significantly exceeded availability. Conversely, forested areas with less than 75% canopy coverage were mainly used less than their occurrence, except during the calving season when open areas were used slightly in excess of availability.

Table 27. Percentages of availability and elk use related to study area overstory canopy coverage, 1979.

Overstory Canopy Cover	N	% Availability 400	% Elk Use				Total 361
			Calving 43	Summer 164	Rut 91	Hunt 63	
OPEN		8.0	14.0	--2.4	-2.2	--0.0	-3.3
< 25%		13.0	11.6	13.4	--4.4	--1.6	8.9
25-75%		36.3	20.9	25.0	--16.5	--11.1	--19.9
75-95%		33.0	39.5	38.4	++56.0	++58.7	++46.5
95-100%		9.8	14.0	++20.7	20.9	++28.6	++21.3

Elk locations were characterized by a habitat classification scheme that was developed by crosstabulating canopy coverage and successional stage, and by adding arbitrary non-forest types. With this scheme, patterns of elk use with regard to structural characteristics of timber stands were more easily determined. Table 28 gives the percentage of locations recorded in each type. Use of mature-old, mixed-species stands was primarily concentrated in dense and closed canopy types. Total use was significantly greater than availability; seasonal use was 2-3 times greater than availability. Light-moderate canopy, pole-young, mixed-species stands were generally less preferred than dense-closed stands. For all seasons, use of the latter exceeded availability, significantly so during the rutting and hunting seasons, and for the entire season. Use of lodgepole types approximated availability. Clearcuts were prominently used during calving. Climax and seral grass-forb areas accounted for a small portion of the study area, and were little used.

Table 28. Percentages of availability and elk use related to habitat age and canopy coverage, 1979.

Age, Spp., Canopy Cover ^a	N	% Availability	% Elk Use				Total
			Calving	Summer	Rut	Hunt	
		300	43	162	91	63	359
Mature-Old Mixed, Light-Mod.		2.3	4.7	1.2	2.2	0.0	1.7
Mature-Old Mixed, Dense		4.7	18.6	12.3	10.0	9.5	++12.0
Pole-Young LPP, Light-Mod.		1.0	0.0	0.0	1.1	0.0	0.3
Pole-Young LPP, Dense		13.7	4.7	10.5	15.6	17.5	12.3
Pole-Young Mixed, Light		7.3	9.3	10.5	3.3	--0.0	6.7
Pole-Young Mixed, Mod.		31.3	18.6	22.8	--14.4	--11.1	--18.2
Pole-Young Mixed, Dense		23.3	30.2	35.8	++52.2	++60.3	++43.6
Brush-Seedling-Sapling		1.3	0.0	1.9	0.0	1.6	1.1
Dry Meadow		1.3	0.0	0.0	1.1	0.0	0.3
Wet Meadow		0.7	0.0	0.0	0.0	0.0	0.0
Pasture-Hayfield		6.3	--0.0	--0.0	--0.0	--0.0	--0.0
North Slope Clearcut		2.7	14.0	1.9	0.0	0.0	2.5
Road		2.0	0.0	1.9	0.0	0.0	0.8
Other ^b		2.0	0.0	1.2	0.0	0.0	0.6

^aCanopy Cover: light < 25%; moderate 26-75%; dense > 75%.

^bOther: brushy riparian, water, scree, rock.

Table 29 shows elk use by habitat type (Pfister et al., 1977). During the calving season, no significant preference for habitat type was noted, but the PSME/CARU type was utilized the most, with use about 3 times greater than availability. PSME/LIBO, ABLA/LIBO, and ABLA/XETE-VAGL types were also heavily used. A habitat type preference during the summer was not clearly defined. Use was well distributed among the PSME/LIBO, PSME/CARU, ABLA/MEFE, and ABLA/XETE-VAGL types. A shift in elk use to more mesic

habitat types was noted during the rut. ABLA/XETE-VAGL, /MEFE, /LIBO, and /CACA types received the most use, the first with use significantly greater than availability. By hunting season, the majority of elk were located in the ABLA/MEFE and /XETE-VAGL types, with use of the MEFE type significantly exceeding availability. For the total period, the percentage of locations was greatest in the ABLA/MEFE type, but, was nearly the same as the availability of that type. The ABLA/LIBO and /XETE-VAGL habitat types were used significantly greater than their availability. High use of the PSME/CARU and LIBO types was also noted. PSME/SYAL and /VACA habitat types were utilized significantly less than their occurrence.

Table 29. Percentages of availability and elk use related to study area habitat types, 1979.

Habitat Types	%	% Elk Use				
	Availability	Calving	Summer	Rut	Hunt	Total
	N 300	43	164	91	63	361
Dry Meadow	1.3	0.0	0.0	1.1	0.0	0.3
Wet Meadow	0.7	0.0	0.0	0.0	0.0	0.0
Pasture - hayfield	6.3	--0.0	--0.0	--0.0	--0.0	--0.0
North Slope Clearcut	2.7	14.0	1.8	0.0	0.0	2.5
Road	2.0	0.0	1.8	0.0	0.0	0.8
PSME/bunchgrass	5.7	--0.0	2.4	1.1	1.6	1.7
PSME/VACA	13.0	--2.3	--1.8	6.6	--1.6	--3.0
PSME/PHMA	2.3	2.3	3.7	3.3	0.0	2.8
PSME/VAGL	1.3	4.7	4.3	0.0	0.0	2.5
PSME/LIBE	10.7	11.6	11.6	7.7	12.7	10.8
PSME/SYAL	18.0	7.0	12.2	--5.5	--4.8	--8.6
PSME/CARU	8.7	25.6	15.2	11.0	4.8	13.6
ABLA/CACA	2.7	2.3	7.9	11.0	1.6	6.9
ABLA/LIBO	4.3	14.0	9.8	12.1	14.3	++11.6
ABLA/MEFE	11.3	4.7	15.2	17.6	++36.5	18.3
ABLA/XETE-VAGL	6.7	11.6	11.0	+22.0	22.2	++15.8
ABLA/XETE-VASC	0.3	0.0	0.0	1.1	0.0	0.3
Other	1.9	0.0	1.2	0.0	0.0	0.6

Disturbance relationships.

Distance to the nearest site of active human disturbance was recorded for each elk location. Whenever possible, distances were measured from elk locations to specific sites of human activity, such as logging and road building, as observed while tracking elk from the air. Otherwise, general areas of disturbance for discrete time periods were used. Road building activities in the study area were previously discussed in the pellet-group section. Logging occurred from late May through June on most of the westerly slopes of Blacktail Mountain, and on the lower portions of the adjacent southerly slope. From mid-July to early September, several

small areas were logged at the head of the North Fork of Elk Creek and Cap Wallace Gulch. An area on the ridge separating the above drainages was also logged at this time. Two small areas were logged in lower Bear Creek from late August to late October. Limited logging took place from mid-October through the end of the study period in the area adjacent to, and just south of the Potter Trap. Extensive logging took place throughout the study period in areas to the east of the study area, mainly in the Pearson Creek drainage and along the River Junction Road east of Pearson Creek. In addition, small pre-commercial thinning operations took place in the large clearcuts in Little Fish Creek from mid-May through August, and in a small area southwest of the Grace's Landing Trap, at the west end of the West Fork Chamberlain Creek drainage, during late May.

For analysis purposes, locations that were closer to an open road with heavy traffic, than to a disturbance site, were eliminated. Table 30 shows the relationship between elk use and distance to disturbance. Elk significantly avoided areas within 0.5 miles (0.8 km) during the summer and rutting seasons, and use significantly exceeded availability in areas greater than 2.0 miles (3.2 km) from disturbance during the rut. An even greater negative response was noted during the summer. Elk significantly avoided areas that were less than 1.0 mile (1.6 km) from disturbance, and significantly selected areas greater than 2.0 miles (3.2 km) from disturbance. Areas at intermediate distances were used about equal to their occurrence. A finer breakdown of distances into $\frac{1}{4}$ mile intervals revealed similar results.

Table 30. Percentages of availability and elk use related to logging and road building activities in the study area, 1979.

Distance to Activity in Miles	Calving		Summer		Rut	
	N	Avail. Use	Avail. Use		Avail. Use	
		210 42	110 150		176 51	
0.0-0.5		15.7 -4.8	37.3 --2.0		35.8 --5.3	
0.5-1.0		17.6 19.0	21.8 -8.0		23.3 40.4	
1.0-1.5		12.4 9.5	26.4 24.0		25.0 24.6	
1.5-2.0		21.0 35.7	13.6 18.7		14.8 14.0	
>2.0		33.3 31.0	0.9 ++43.3		1.1 +15.8	

The distance to new roads in the CSA was also measured from each location (Table 31). There was a non-significant trend to higher use of areas greater than 550 yards (500 m) from new roads, than for areas less than 550 yards (500 m). Notably, there was no selection for areas on the opposite side of 3rd and 4th order ridges from new roads, many of which were being worked on during the study period. This trend was consistent during the summer, rut and hunt; but during the calving season high use was recorded at distances 150-550 yards (140-500 m) from new roads.

Table 31. Percentages of availability and elk use related to distance to new roads in the CSA, 1979.

Distance to New Road in yards (meters) ^N	% Availability 300	% Elk Use				
		Calving 43	Summer 164	Rut 91	Hunt 63	Total 361
0-150(0-140)	1.7	0.0	1.2	3.3	0.0	1.4
150-550(140-500)	5.3	16.3	3.0	3.3	3.2	4.7
550-950(500-870)	3.7	14.0	7.9	4.4	6.3	7.5
950-1350(870-1230)	3.3	9.3	6.7	9.9	4.8	7.5
>1350 (>1230)	19.7	11.6	28.0	20.9	30.2	24.7
Out of Range ^a	66.3	48.8	-53.0	58.2	55.6	--54.3

^aOut of Range: locations on opposite side of major ridge from new roads.

Vehicular use of the study area was light (less than 1 vehicle trip/day) to moderate (1-4 vehicle trips/day) during 1979. Heavy traffic (5-9 vehicle trips/day) occurred on the lower portions of the main Chamberlain Creek Road during the calving and hunting seasons. During the rut, traffic was heavy on all sections of the main Chamberlain Creek Road. The Cap Wallace Road, to the head of the North Fork of Elk Creek, was moderately to heavily used throughout the season until 5 September. Elk did not appear to avoid open roads during the calving and summer seasons (Table 32). Traffic was generally light on roads located in areas used by elk during these seasons, so it is not remarkable that roads were not avoided. An apparent avoidance of open roads was noted during the rutting and hunting seasons. Use was significantly lower than availability in areas less than 550 yards (500 m) and 950 yards (870 m) from open roads during these seasons, respectively. In addition, respective use for these seasons of areas greater than 1,350 yards (1,230 m) from roads was 70% and 90%, both significantly exceeding availability. This phenomenon may be partially explained by the decreased availability of open roads effected by the general road closure after 1 September. Approximately 90% of the roads open after 1 September were moderately to very heavily (more than 9 vehicle trips/day) traveled, and were generally located along the periphery of the study area. During the rutting season, elk did not avoid roads with moderate traffic; however, areas within 550 yards (500 m) of roads with similar traffic were avoided during the hunting season. Elk significantly preferred areas greater than 1,350 yards (1,230 m) from heavily traveled roads during both seasons. Areas within 150 yards (140 m) of roads closed after 1 September were used significantly less than availability during these seasons. Use of areas beyond this distance, approximated availability.

Table 32. Percentages of availability and elk use related to distance to open roads, 1979.

Distance to Open Roads in yards (meters)	N	Calving		Summer	Rut		Hunt	
		Avail.	Use	Use	Avail.	Use	Avail.	Use
		300	43	164	300	91	300	63
0-150(0-140)		30.7	34.9	32.3	10.7	-3.3	5.7	--0.0
150-550(140-500)		39.3	48.8	32.3	24.3	--3.3	12.7	--1.6
550-950(500-870)		17.7	14.0	16.5	15.7	11.0	10.0	3.2
950-1350(870-1230)		9.0	2.3	17.7	14.0	12.1	9.3	3.2
>1350(>1230)		3.3	--0.0	1.2	35.3	++70.3	62.3	++92.1

It is clear from Table 33 that elk preferred unlogged areas over logged areas. Use of unlogged areas was significantly greater than availability during the summer, rutting and hunting season, and for the whole season. Calving season use was equal to that of summer, but was not significant. In general, use of pre-1970 cuts, which are almost entirely some type of partial cut, was equal to availability during the calving season, but decreased during each successive season. At the same time, use of unlogged areas correspondingly increased. A finer breakdown of use in logged areas, by the decade during which the area was cut, indicated that use of cuts made before 1949 was generally lower than availability, while later cuts were used about equal to or less than their occurrence. However, relatively high use of cuts completed from 1960 to 1969 was observed during the calving season: this is explained by a preference for clearcuts at that time, most of which were made in the 60's. Use of unforested areas was not observed. This pattern of use may be explained by a seasonal preference for more mesic higher elevational ranges, which are unlogged, rather than an avoidance of logged areas, which are mainly at lower elevations.

Table 33. Percentages of availability and elk use related to logged areas, 1979.

Time of Logging	N	%	% Elk Use				Total
			Calving	Summer	Rut	Hunt	
		Availability	43	164	91	63	361
		300					
1970-1979		11.7	9.3	14.6	--3.3	4.8	9.4
1960-1969		8.7	23.3	9.1	4.4	3.2	8.6
1950-1959		6.0	9.3	3.7	9.9	3.2	5.8
Pre-1949		34.3	-16.3	29.3	24.2	--15.9	-24.1
(Unlogged)		29.7	41.9	+43.3	++58.2	++73.0	++52.1
(Non-forested)		9.7	--0.0	--0.0	--0.0	--0.0	--0.0

Relative Hunter Use and Elk Harvest

The study area is in Hunting District 292, and also largely within the Blackfoot Special Management Area (BSMA), where roads are closed to vehicular access from 1 September through 1 December. This area was open for either sex archery hunting for elk from 8 September through 14 October 1979. There was also a general hunting season for antlered males and for either sex by special permit only, from 21 October through 25 November. Either sex permits were increased from 50 in 1978 to 75 during 1979, even though a substantial area in the western portion of H.D. 292 was closed to either sex hunting last season.

The total number of hunters checked at the Bonner check station during the 1979 general hunting season was 4,879 (Hartkorn 1979), approximately the same number as was checked the year before. A harvest of 50 elk was recorded during 1979, 29 from the BSMA and 21 from nearby surrounding areas. Fifty elk were also taken in the area during 1978. Three elk were taken by archers in 1979. Thirty-one (62%) of the elk harvested in 1979 were males (17 spikes and 14 branch-antlered), 14 (28%) were females, and 5 (10%) were calves.

DISCUSSION

We have now collected four years of pellet count data on all transects within the core study area (CSA). Several conclusions which we reported previously (Scott 1978, and Marcum et al. 1979) are reinforced after including results derived from the 1979 data. Chamberlain Creek elk continue to make almost universal use of the available habitats in the CSA. No habitat component has been preferred throughout all years and seasons, but elk use has been consistently less than availability on primary upper slopes and ridgetops, dense small diameter lodgepole pine stands (pole-sapling successional stage), and on areas which are greater than 450 yards (410 m) from water. Except for spring and fall 1978 elk use of steep slopes ($>30^{\circ}$) has also been less than availability. To date, the primary factors which have influenced habitat use patterns by elk in the CSA have been a combination of weather plus vegetative composition, structure, and phenology.

Old and very old (OVO) pellet groups recorded during the spring 1979 count were considered to represent elk use in the CSA during fall 1978. The OVO pellets were located primarily on gentle ($0-15^{\circ}$) mid-slopes or secondary upper slopes and ridges, on westerly aspects, and at elevations of 5,700-6,200 feet (1,740-1,890 m). Relative to summer 1978, fall 1978 elk use increased at lower elevations, and in more open old stands within Douglas-fir habitat types with bunchgrass understories.

During the drought spring of 1977, elk preferred southern subunits in the CSA at higher elevations, gentle slopes, and young stands of medium to large lodgepole pine in subalpine fir habitat types with mesic understory species. Conversely, elk preferred northern subunits at lower elevations, moderate to steep slopes, and old stands of large Douglas-fir in Douglas-fir habitats with more xeric understory species during the relatively wet spring of 1978. Precipitation during 1979 was slightly less than normal, and intermediate to that during 1977 and 1978. Similarly, the amount and patterns of habitat use by elk during spring 1979 were intermediate to, but less selective than, those of the other 2 years. Although partially a result of differences in sample size, spring elk use was significantly different from availability for only 10 environmental components during 1979, as compared to 16 during 1977 and 26 during 1978. However, spring 1979 use tended to exceed availability in both the more open stands of large Douglas-fir with pinegrass and heartleafed arnica dominated understories, and in the more dense and younger stands of subalpine fir and Engelmann spruce in subalpine fir habitat types with more mesic understory species. During all 3 springs, elk preferred clearings or open stands (canopy cover 0-25%) with sight distances greater than 100 yards (90 m), but to a much greater extent in 1977 and 1978 than in 1979. In general, these results demonstrate the ability of elk to adjust their yearly patterns of habitat selection and use to yearly variations of environmental conditions.

As during previous years, elk use in summer shifts to more mesic habitats at higher elevations. The pellet count results for summer 1979 are similar to those for the summers of 1976 and 1978, in that there was a high degree of uniformity in habitat selection by elk in the CSA. Elk use differed significantly from availability for only 10 habitat attributes during the summers of 1978 and 1979, and for 12 during 1976. There were 46 significant differences recorded for summer 1977. As reported previously (Marcum et al. 1979), the patterns of relative habitat category use by elk in the CSA are similar for all summers; especially for elevation, aspect, topography and distance to water. The major yearly differences in summer elk use have been the very heavy selection of the more mesic vegetative sites and the great increase in total elk use of the CSA during the drought year of 1977, as compared to the wetter years of 1976 and 1978. As noted previously, precipitation for 1979 was slightly less than normal, and intermediate to that for 1977 and 1978. As expected, total elk use of the CSA during summer 1979 was intermediate to the total use recorded during the summers of 1977 and 1978. However, summer habitat selection by elk during 1979 was more similar to that of the wetter years of 1976 and 1978, than it was to the drought year of 1977. Last year we proposed that logging activities on high elevation, mesic summer ranges during dry years, when elk are concentrated in these habitats, might be more disturbing to elk than logging during wet years, when elk are likely to be more widely distributed. The 1979 results support this conclusion, but they indicate that the effects would be relatively much greater during a very dry year than during a moderately dry year.

During fall 1978, and spring and summer 1979, human disturbance associated with road construction in the CSA was light and intermittent, and was confined primarily to the northern end of the area. Elk avoided areas within 150 yards (140 m) of the new roads during all three seasons. Because this disturbance was intermittent, whereas elk use recorded by accumulations of pellet groups is relatively constant, the immediate displacement of elk by this kind of disturbance could have been much greater than the data indicate. Activities associated with logging will increase considerably next year, so results derived from pellet counts concerning the response of elk to human activities should be more definitive. As in previous years, apparent avoidance by elk of old roads and logged areas during 1979 can be attributed to other factors of habitat selection, and no distinct patterns of elk distribution with respect to planned roads or cutting units were noted.

Last year, we presented results showing a very high correlation between precipitation and elk use in the CSA (Marcum et al. 1979). The correlation remains after including the 1979 data in the regression equation. This reinforces our conclusion that, when there is little human activity in the area, elk habitat use patterns in the CSA, and total use of the CSA are influenced primarily by direct and indirect influences of weather variations. The relationship shown between

precipitation and elk use is perhaps the most important result of the study thus far. It aids us greatly in interpreting seasonal and yearly changes in the use of various habitat components by elk. Also, we know that total elk use of the CSA varies substantially during different years, even in the relative absence of human disturbance. Thus, it would be very difficult to assess the influence of planned logging activities on the levels of elk use in the CSA if we could not predict what the level of use would have been under undisturbed conditions.

Telemetry results for 1977, 1978, and 1979 point out the importance of the CSA to elk in the study area. The CSA encompasses the majority of the high elevation mesic areas in the study area. Total use was significantly greater than availability for all three years ($p \leq 0.01$). The year-to-year trend in total use appears to be related to yearly differences in precipitation. Use was highest during 1977, an extremely dry year, and lowest during 1978, a moist year. Elk use during 1979 was intermediate to that of 1977 and 1978, but was closer to that of 1977. Precipitation followed a similar pattern. A regression of CSA elk use and cumulative precipitation yielded a high negative correlation ($r = -0.8$). The percentage of yearly seasonal activity centers in the CSA showed a similar relationship, but a regression equation was not developed. Some seasonal variations in CSA elk use can be similarly explained in relation to precipitation. Summer use was significantly greater than availability for all three years. Use was greatest during 1977, decreased during 1978, and further decreased during 1979. If summer use were to follow the trend of total use in relation to precipitation, use during 1979 should be greater than during 1978 and approximate that of 1977. However, precipitation was only slightly below normal through May 1979, whereas during 1977 precipitation was well below normal for the same period. Consequently, sufficient moisture was available for spring plant growth and to delay dessication of vegetation at low elevations outside the CSA, thus providing elk with relatively more suitable foraging areas during 1979. The decreased use of the CSA during 1979 can further be attributed to a greater use by Lindberg-Potter elk of mesic, high elevation areas to the west of the CSA than of similar areas within the CSA. Use of the CSA during the rut was similar during 1977 and 1978, but was substantially higher during 1979. The fact that the fall of 1979 was unusually hot and dry accounts for this pattern of use. The trend of use during the 1979 hunting season was similar to that of the rut. This trend was probably the result of elk remaining in areas used during the rut, and hunter pressure forcing elk into areas which were least accessible and that had heavy cover. Most of these areas are in or adjacent to the CSA.

A breakdown of elk use by trap groups indicated that Grace's Landing elk consistently used the CSA more than the Lindbergh-Potter elk during all 3 years. As in previous years, little overlap of home ranges occurred between these groups. A relatively greater amount of preferred summer range of the Grace's Landing elk, as opposed to the Lindberg-Potter elk, occurs in the CSA. The former group will therefore be most impacted by future logging activities in the CSA.

Limited information is available on the movements of the 4 bull elk radio-collared in the study area. Most bulls were not located for an entire season due to various reasons. Two transmitters failed; 1 was broken off; 1 bull died; and 1 was not located after the summer of 1979. Bull elk No. 49, trapped at Grace's Landing, was successfully tracked during 1978 and for most of 1979. During 1978, as a 2-year-old, he was found during the calving and summer seasons east of the CSA, and during the rutting and hunting seasons in or near the CSA. During 1979, the initial spring locations for this animal were north of the CSA. He then moved east to the Pearson Creek drainage, next to the head of Wales Creek, and was last located south of the Chamberlain Burn in late August. Two bull elk, 4 and 5 years old, radio-collared at the Grace's Landing trap during the winter of 1977-78, generally used the study area little. They ranged widely to the east of the CSA, using the Pearson, Frasier, and Wales Creek drainages. The 4-year-old broke its collar off in late August, and the 5-year-old died of unknown causes in early July. A yearling bull was radio-collared at the Lindbergh Trap during the winter of 1978-79. Before its transmitter failed in early June, the bull was located in an area traditionally used by cow elk collared at the same trap. He was killed during the hunting season near Hungry Horse Reservoir, about 100 airline miles north of the study area. Hopefully, more bulls will be radio-tagged and successfully tracked in the future to provide more information concerning their movements and distribution.

Yearly average values for seasonal distribution and movement statistics were quite variable. Home range size, average distance moved between successive locations, and standard diameter during the 1979 calving season were intermediate between high values for 1977 and low values for 1978. During the summer seasons, values for these variables were highest in 1978, followed by 1979 and 1977. The rutting season home range area was highest in 1977, decreased in 1978, and again decreased in 1979. Average distance moved between successive locations during the rutting season was nearly equal all 3 years. Rutting season standard diameters were highest in 1977, followed by 1979 and 1978. Hunting season home range area was greatest in 1979, intermediate in 1977, and lowest in 1978. Average distance moved between successive locations was likewise highest in 1979, but lowest during 1977. The 1978 value equaled that of 1977. Hunting season standard diameters were lowest in 1977, and successively increased each year. For the entire season, yearly home range size and standard diameter decreased each successive year, whereas average distance moved stayed the same.

Yearly differences in seasonal home range areas and distance statistics for the calving and summer seasons appear to be related to yearly differences in precipitation, as was use of the CSA. During 1977, high elevations were snow-free and forage was available there early in the calving season, while during 1978 snow remained longer at upper elevations, so forage in higher areas was not available until later in the year. An intermediate situation occurred during 1979.

Consequently, during 1978 elk were restricted to smaller areas with suitable forage than during 1977. They were similarly restricted during 1979, but to a lesser degree than in 1978. This was reflected by smaller home ranges and shorter movements during 1978. The opposite of this situation occurred during summers. During 1977, good forage was available only at higher, more mesic habitats which restricted the range of elk movements. Conversely, good forage was available at lower elevations later into the summer of 1978, allowing elk to utilize a larger area. During the summer of 1979 elk movements were intermediate between 1977 and 1979, as was precipitation.

Chamberlain elk used smaller areas than animals east of the Continental Divide in Montana. Over the past three years, Chamberlain elk used an area of about 70-100 mi² (182-260 km²) during the calving through hunting seasons. This also included most of the area used during the winter. Year-long home ranges for 30 radio-equipped elk at the Long Tom study area covered 675 mi² (1,755 km²) (Lonner 1979). Cada (1978) reported year-long home ranges of 143 mi² (370 km²) and 568 mi² (1,471 km²) for 3 elk from the Gallatin Valley and for 9 elk from the Madison Valley, respectively. Seasonal averages of home range areas, average distance moved between location, and standard diameters for Lonner's elk were higher than those for Chamberlain elk during all seasons. Lonner also reported large yearly differences in seasonal movements and home ranges for individual elk. Also, elk reported on by Lonner and Cada generally tend to migrate much greater distances between summer and winter ranges than do Chamberlain elk. Yearly differences in movements and home range size between elk east and west of the Continental Divide may be related to migratory tradition, and the distances elk must travel between acceptable winter and summer ranges. Seasonal differences may be attributable to yearly variations in movements and home ranges, differences in habitat between areas, sample size, or perhaps a combination of these or other factors.

Telemetry results for 1977, 1978, and 1979 indicate that habitat utilization of radio-collared elk in the study area was variable. However, some patterns of use are evident for the May to December study periods. Elk primarily used 5,100-6,200 feet (1,530-1,860 m) elevations, significantly during 1978 and 1979. During 1977, elk preferred the 5,700-6,200 feet (1,740-1,890 m) interval within this range. Low elevation areas, between 3,800 and 4,400 feet (1,140-1,320 m), were consistently used significantly less than availability. Use of different slope positions was variable, but upper and mid-slopes were used the most. Mid-slopes were significantly preferred in 1977, while during 1979 upper slopes of secondary ridges were significantly preferred. Ridgetops, primarily secondary ridgetops, were also used in excess of availability, significantly so during 1978 and 1979. Lower slopes were consistently used significantly less than their occurrence. There was no evident preference for drainage bottoms or drainage heads. Concave configurations were used greater than their occurrence, significantly so during 1977 and 1978. Use of other configurations (convex, straight, and undulating) was equal to, or slightly less than availability.

There was generally no consistent preference shown by radio-collared elk for overstory canopy cover classes during the 3 years considered here. Most elk use was in moderate to dense stands; however, use of dense and closed stands increased during 1979 to significantly exceed availability. Pole-young, mixed tree species stands received the greatest use, but were generally used in proportion to their occurrence. Within this type, though, stands with dense canopy coverage were slightly preferred. Mature-old, mixed species stands were always used greater than their availability: stands with dense canopy cover were preferred, significantly so during 1978 and 1979. ABLA/XETE-VAGL and ABLA/LIBO habitat types received the greatest use relative to availability. ABLA/CACA and PSME/CARU types were also preferred. The ABLA/MEFE habitat type was used the most, but not in excess of availability. PSME/VACA and PSME/SYAL habitat types were consistently used less than their occurrence. Little preference was shown for slope, aspect, and for areas near water or moist sites. With respect to slope and aspect, gentle slopes ($0-15^{\circ}$) were slightly preferred during 1979, but flat areas (no aspect) were significantly underutilized. This incongruity is resolved by the fact that most of the use of gentle slopes was not on 0° slopes or flats. Regarding use of moist areas, Marcum (1975) found that elk in the Sapphire Mountains significantly preferred areas within 50 yards (46 m) of water. However, water or moist sites are much more prevalent in the Chamberlain area, than in the Sapphire area. Productive areas near water are no doubt important to Chamberlain elk, as indicated by the relatively high use of the moist ABLA/CACA habitat type. But, the availability of such areas appears not to exert as great an influence on the distribution of Chamberlain elk, as it does in areas where moist sites are less available.

Seasonal patterns of habitat utilization were more variable than total use patterns, but some trends are evident. During all calving seasons, 5,100-5,600 feet (1,150-1,700 m) elevations were significantly preferred. During 1978, lower elevations (4,500-5,000 ft; 1,370-1,520 m) were also prominently used; while during 1979, these same low elevations plus higher elevations (5,700-6,200 ft; 1,740-1,890 m) were heavily used. Elk used upper and mid-slopes, primarily upper slopes of secondary ridges, the most, generally in excess of availability. Secondary ridgetops were also favored in 1979. Little selectivity for aspect was observed during calving seasons: north, northeast, west and northwest aspects were mainly used. With regard to canopy coverage, use was quite variable. Moderate cover was preferred during 1977; light cover was significantly favored during 1978; and dense cover was used the most during 1979. Pole-young, mixed tree species stands were used the most. Light canopy coverage in this type was generally favored, whereas moderate and dense canopy areas were used less than, and equal to their occurrence, respectively. Mature-old, mixed tree species stands were always preferred, especially stands with dense canopy. Use of clearcuts, which account for only 2.7% of the study area, was variable: no use was observed in 1977, but 7.5% and 14.0% use was recorded for 1978 and 1979, respectively. PSME/CARU and ABLA/LIBO were the preferred habitat types during the calving seasons.

Elk were found at a broader range of elevations during summers. The greatest use occurred in areas of 4,500-6,200 feet (1,370-1,890 m) elevation. A significant preference for 5,700-6,200 feet (1,740-1,890 m) elevations was noted for all years. Lower elevations (5,100-5,600 ft; 1,550-1,700 m) were significantly preferred during 1978 and 1979; and high use of the 4,500-5,000 feet (1,370-1,520 m) interval also occurred. Upper and mid-slope positions were generally favored. During 1977, a dry year, drainage heads were notably used. Concave slope configurations were favored every summer. Timber stands with dense to closed canopy were used the most, but, except during 1978, not in excess of availability. During summer 1977, use of clearcuts significantly exceeded availability. Pole-young, mixed tree species stands, primarily with a dense canopy received the greatest use; and dense, mature-old, mixed species stands were used greater than their occurrence. Elk were found to use several habitat types. The ABLA/XETE-VAGL, ABLA/LIBO, ABLA/CACA and PSME/CARU types were generally favored. The greatest amount of use was in the ABLA/MEFE type, but use was less than the availability of this plant community.

During the rutting seasons, elk use with respect to elevation was quite inconsistent. Moderately low elevations (4,500-5,000 ft; 1,370-1,520 m) were used most during 1977, even lower elevations (3,800-4,400 ft; 1,140-1,320 m) were used during 1978, and higher elevations (5,100-6,200 ft; 1,550-1,890 m) were chiefly used during 1979. Little consistent preference for slope position was noted during the rutting season. Mid-slopes were preferred during 1977; ridgetops, upper and mid-slopes were all used about equal to availability during 1978; and secondary upper slopes were favored during 1979. Concave slope configurations were preferred, significantly during 1977 and 1979. Dense and closed canopy areas were favored during 1979, otherwise no preference was generally noted. Use of pole-young mixed stands remained high, and mature-old mixed stands continued to be preferred. Use of habitat types was similar to that of summer.

During the hunting seasons, elk generally preferred 5,100-6,200 feet (1,550-1,890 m) elevations. In addition, elk used elevations as low as 4,500 feet (1,370 m) during 1977. However, higher elevations, up to 6,800 feet (2,070 m), were used during 1979. Primary upper slopes and mid-slope positions were favored. Ridgetops were used in excess of availability during all years. No consistent pattern of use was noted for slope configuration. With respect to canopy cover and successional stage, use during hunting season resembled that of the rut. ABLA/XETE-VAGL, ABLA/LIBO, and ABLA/MEFE habitat types were preferred.

Elk appeared to avoid areas within 0.5 mile (0.8 km) of active human disturbance during 1978 and 1979, except during summer 1979 when areas within 1.0 mile (1.6 km) were avoided. Use was also significantly greater than availability for areas greater than 1.5 mile (2.4 km) and 2.0 miles (3.2 km) from disturbance during the summers of 1978 and 1979, respectively. During the 1979 rutting season, use significantly exceeded

the availability of areas greater than 2.0 miles (3.2 km) from disturbance. However, disturbance was generally light during these years, especially during the calving seasons. Also, pellet-group counts and telemetry results indicated that elk use near areas of disturbance would probably have been low, even in the absence of this disturbance. Furthermore, analysis of radio-collared elk use in areas near new roads in the CSA for 1978 and 1979 indicated no avoidance of the new roads. However, these roads, at present, occur in only a small portion of the area available to radio-collared elk. Elk reaction to human disturbance will become more clear in future years when more extensive road building and logging occurs in areas of traditionally high elk use.

Elk reaction to open roads was similar for all three years. Elk did not avoid open roads during the calving and summer season. However, during the rutting and hunting seasons, areas within 550 yards (500 m) were significantly avoided. In addition, there was a significant preference for areas greater than 1,350 yards (1,230 m) from open roads during the latter 2 seasons. This difference may be partially explained by the decreased availability of open roads effected by the general road closure after 1 September. However, roads open after 1 September were heavily traveled, and elk avoided areas within 550 yards (500 m) of these roads during the rut. An even greater negative response to open roads was noted during hunting seasons. For all years, areas within 550 yards (550 m) of roads closed after 1 September were used less than their occurrence, significantly so during the 1979 rutting season, and during the 1978 and 1979 hunting seasons. During the 1977 and 1978 hunting seasons use was less than that for the rutting season; but, the reverse situation occurred during 1979. This apparent avoidance of closed roads may be a result of elk habitat preference for areas away from these roads, or a response to hunters walking roads during the hunting season.

Elk use of logged areas followed a fairly consistent pattern. Areas cut after 1970 were generally used equal to their occurrence, but use was notably high during the 1977 and 1978 rutting seasons. Lands logged before 1970 were used about equal to their availability during the calving seasons, and use generally decreased during subsequent seasons. Elk use of uncut areas correspondingly increased. This pattern of use is probably a result of elk preferring mesic, moderate to high elevation areas that happen to be unlogged, rather than an avoidance of logged areas. Most logged areas are located at lower elevations.

The road closures initiated in the BSMA during 1974 have contributed to increased hunting opportunity and quality in recent years. In particular, the opportunities for either sex elk hunting tend to be increasing here, while they tend to be decreasing in many areas where roads remain open to vehicular access.

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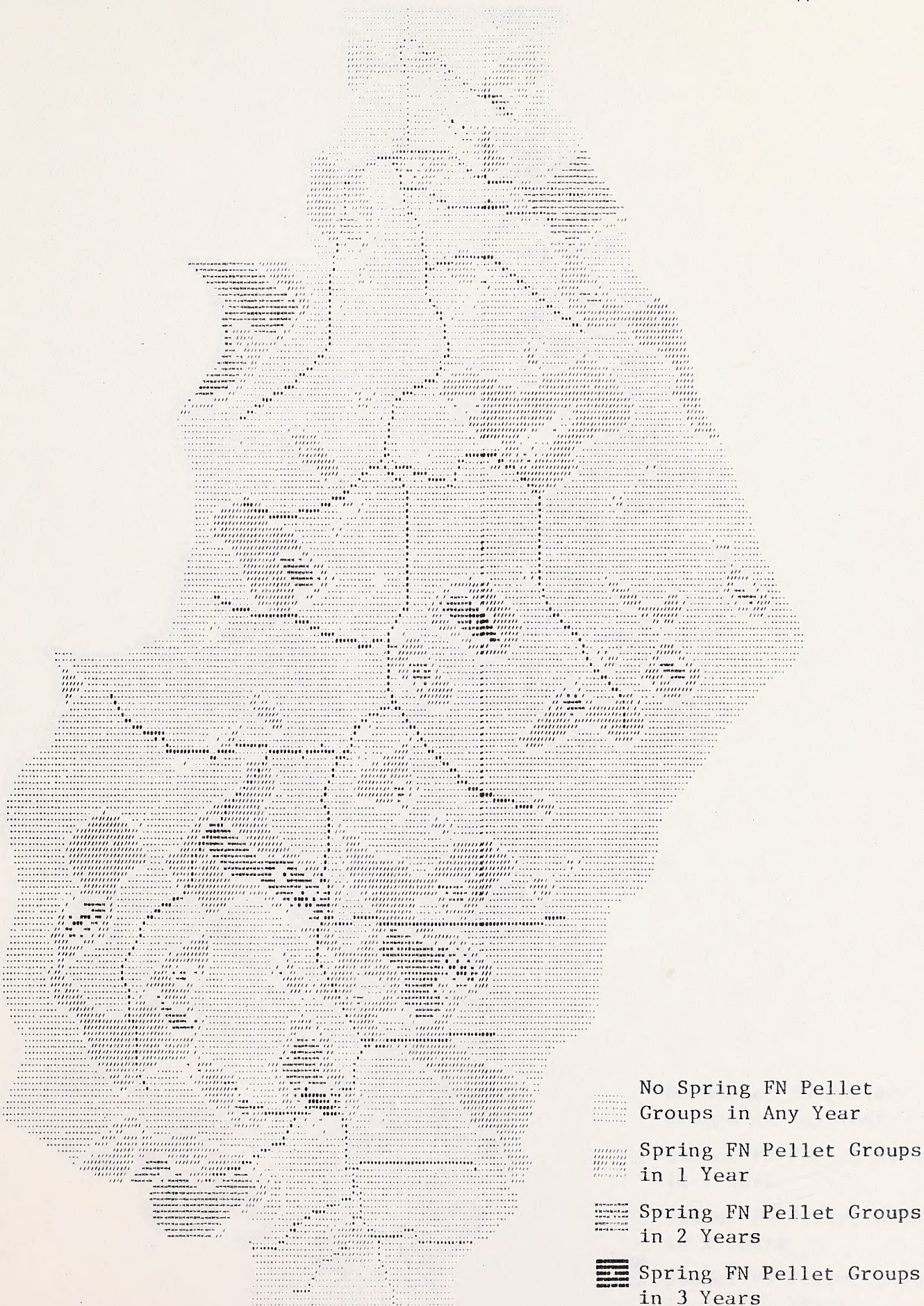


Figure 11. Consistency of CSA elk use for springs, 1977-1978-1979.

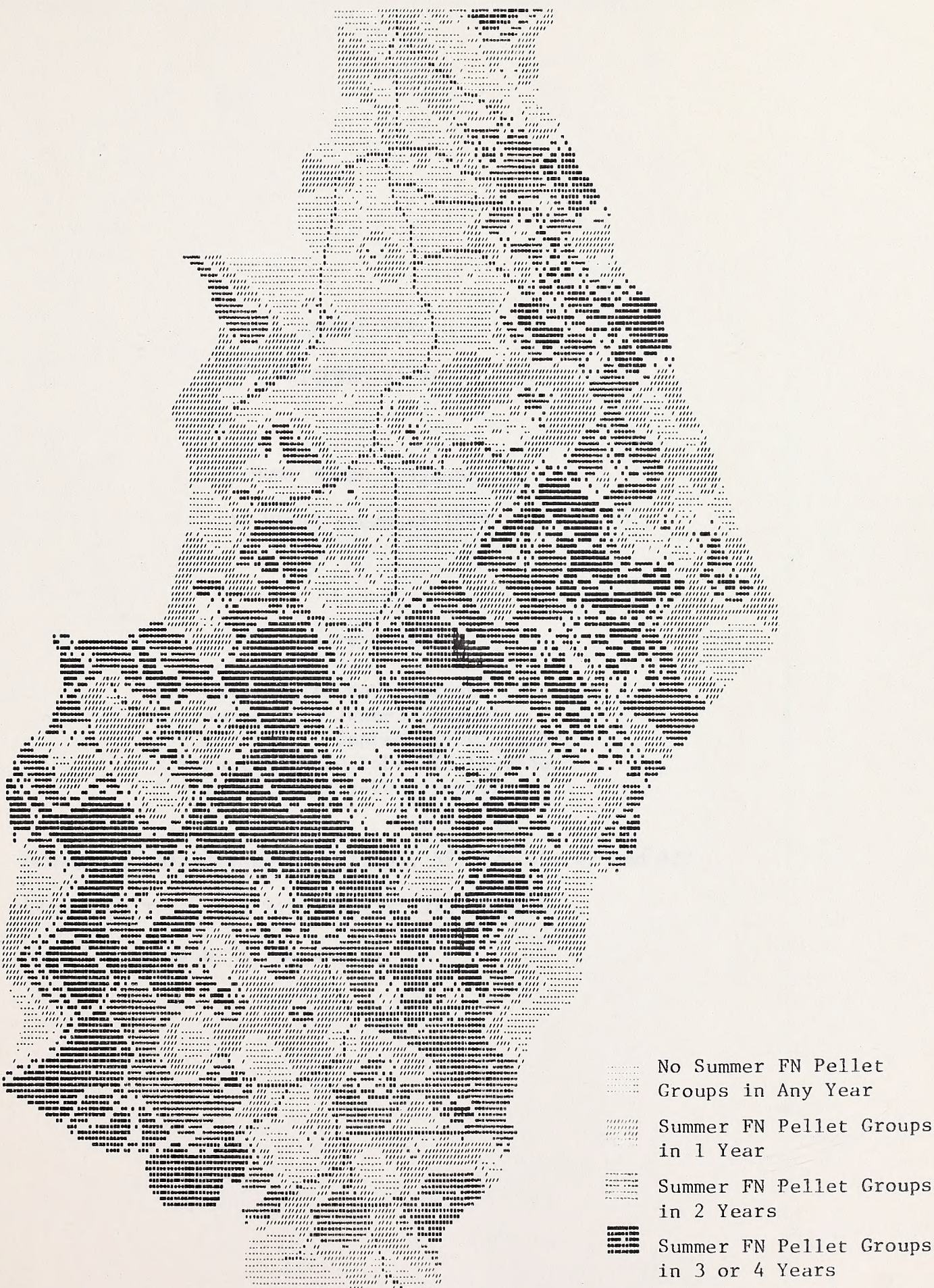


Figure 12. Consistency of CSA elk use for summers, 1976-1977-1978-1979.

LEGEND FOR
FIGURES 13-20

Home Range Polygons
15 May-6 December 1979

Activity Centers

C = Calving, 15 May-15 June
S = Summer, 16 June-31 August
R = Rutting, 1 September-20 October
H = Hunting, 21 October-28 November
T = Total, 15 May-28 November

Grace's Landing Trap--Elk 22, 35, 37, 42, 46, 49 and 411.

Lindbergh Trap--Elk 211, 28, 33, 312 and 41.

Potter Trap--Elk 31, 34 and 39.

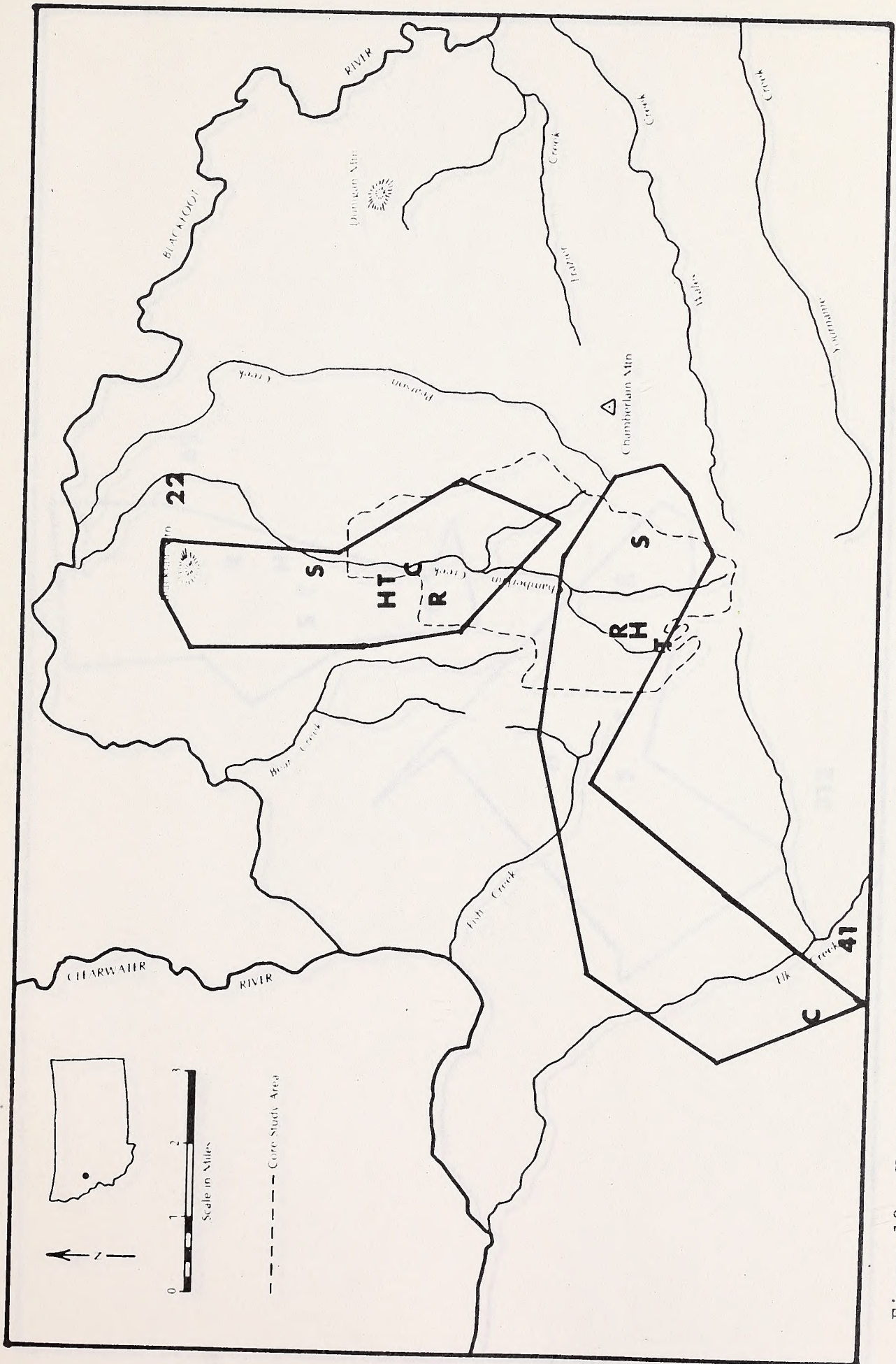


Figure 13. Home range polygons and activity centers for female elk 22 and 41.

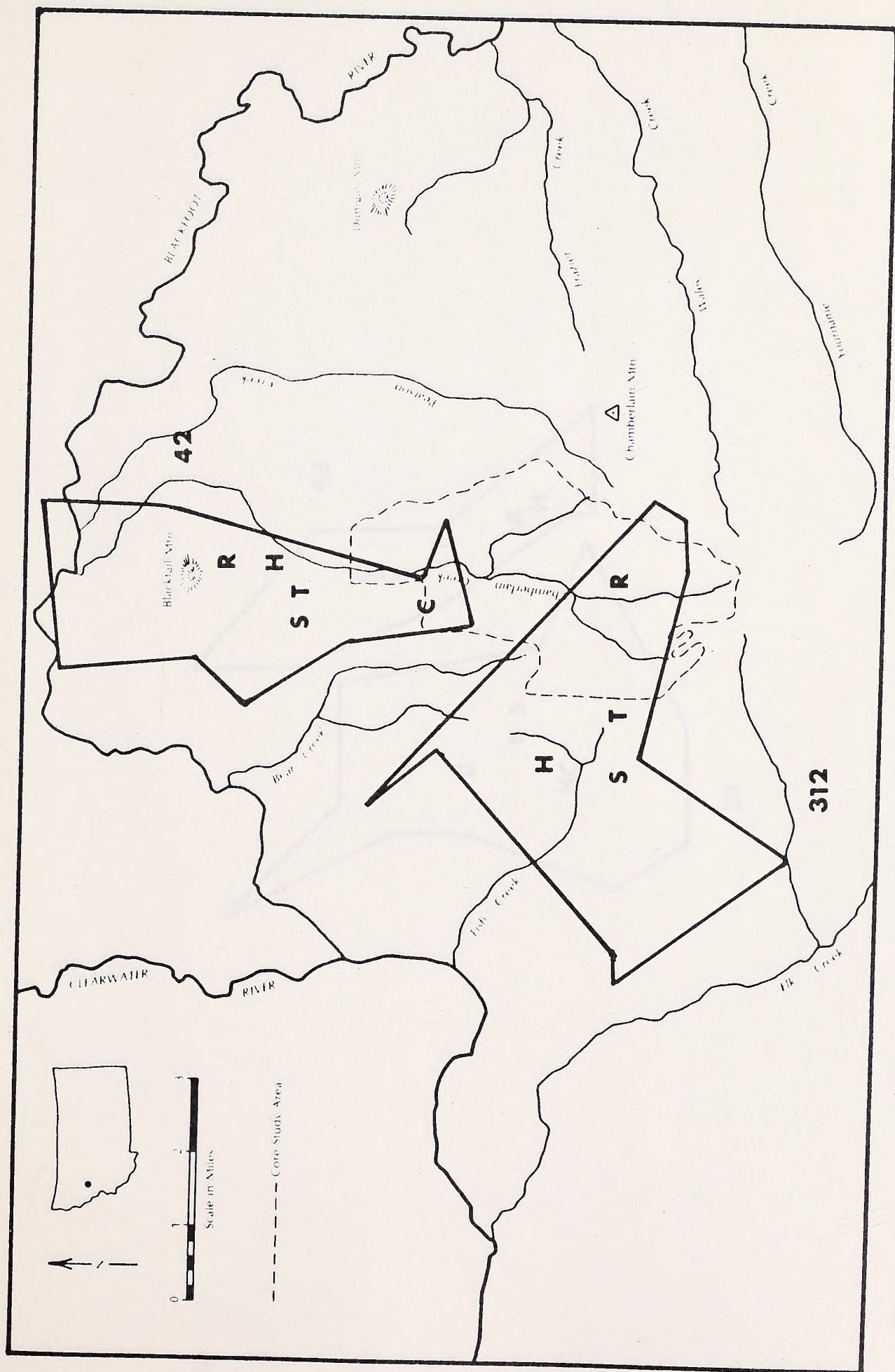


Figure 14. Home range polygons and activity centers for female elk 42 and 312.

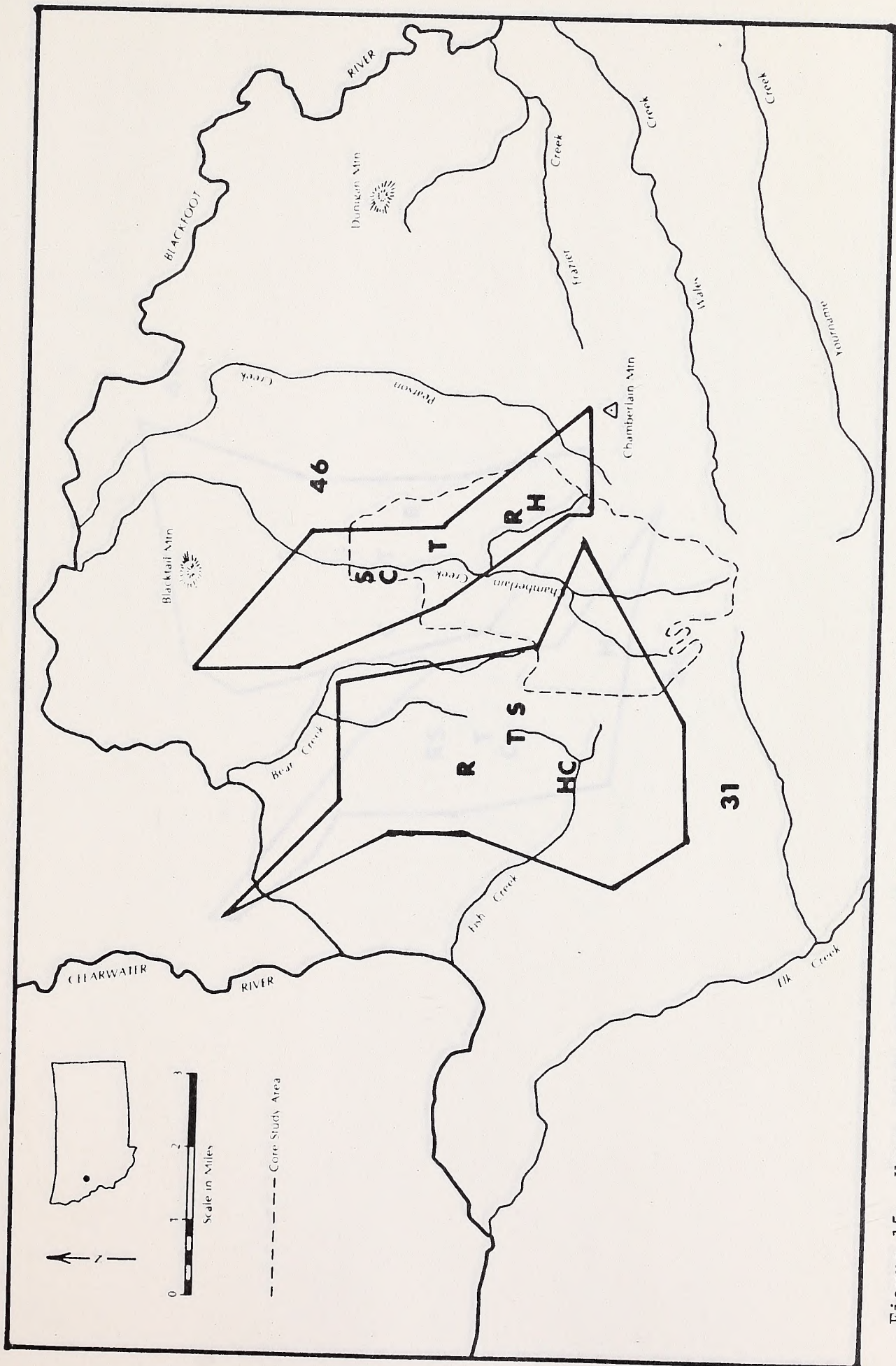


Figure 15. Home range polygons and activity centers for female elk 46 and 31.

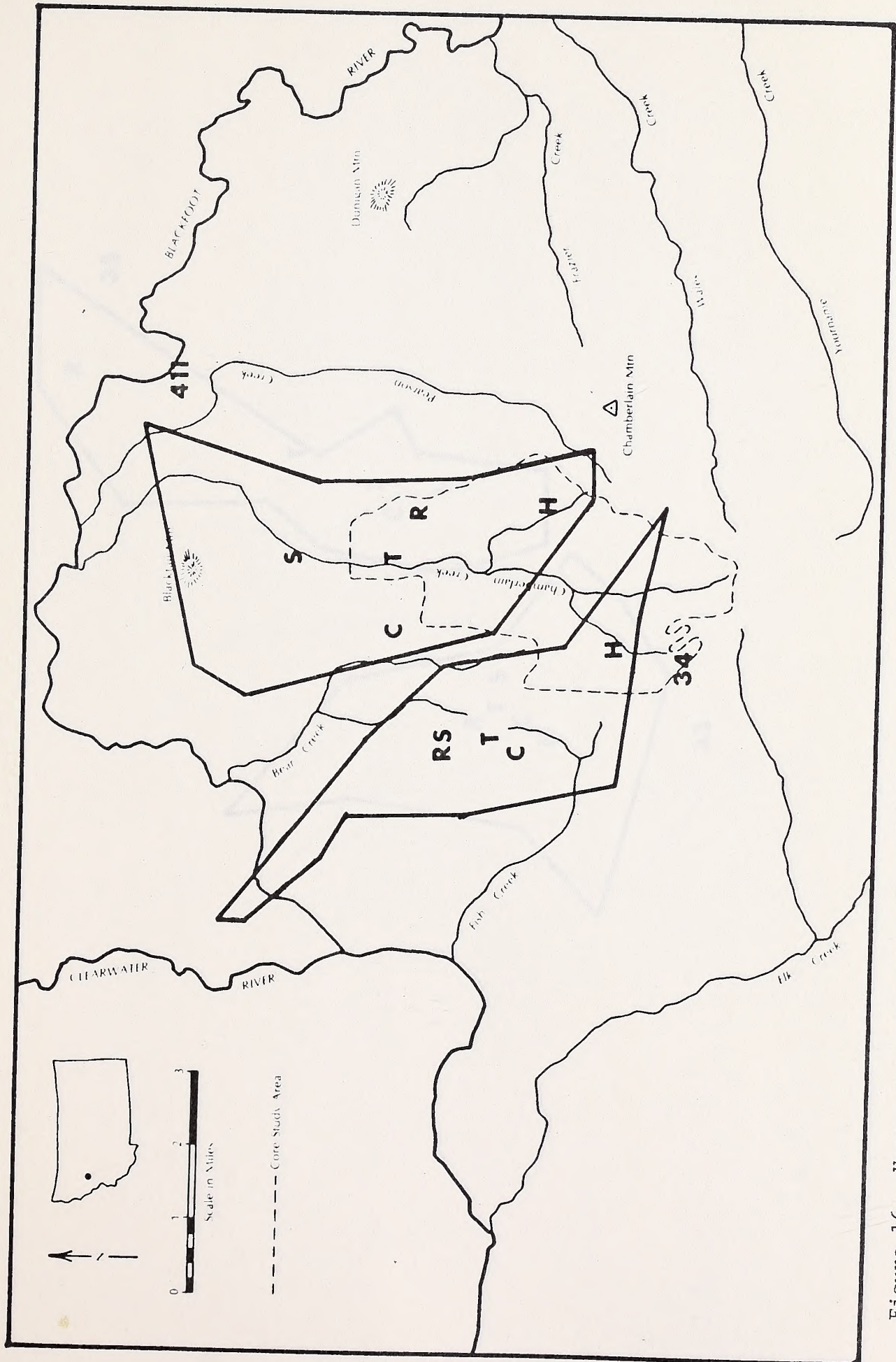


Figure 16. Home range polygons and activity centers for female elk 411 and 34.

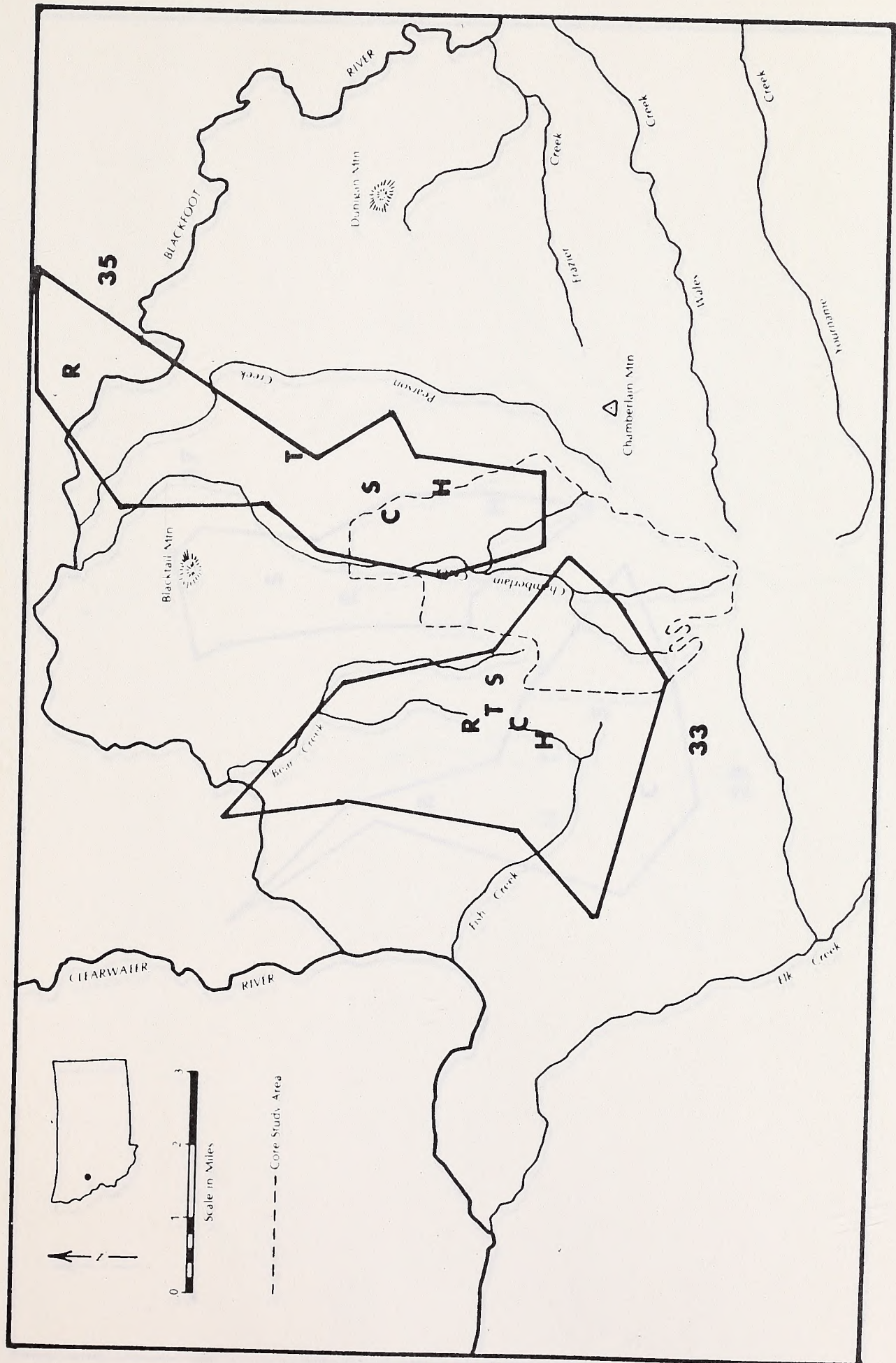


Figure 17. Home range polygons and activity centers for female elk 35 and 33.

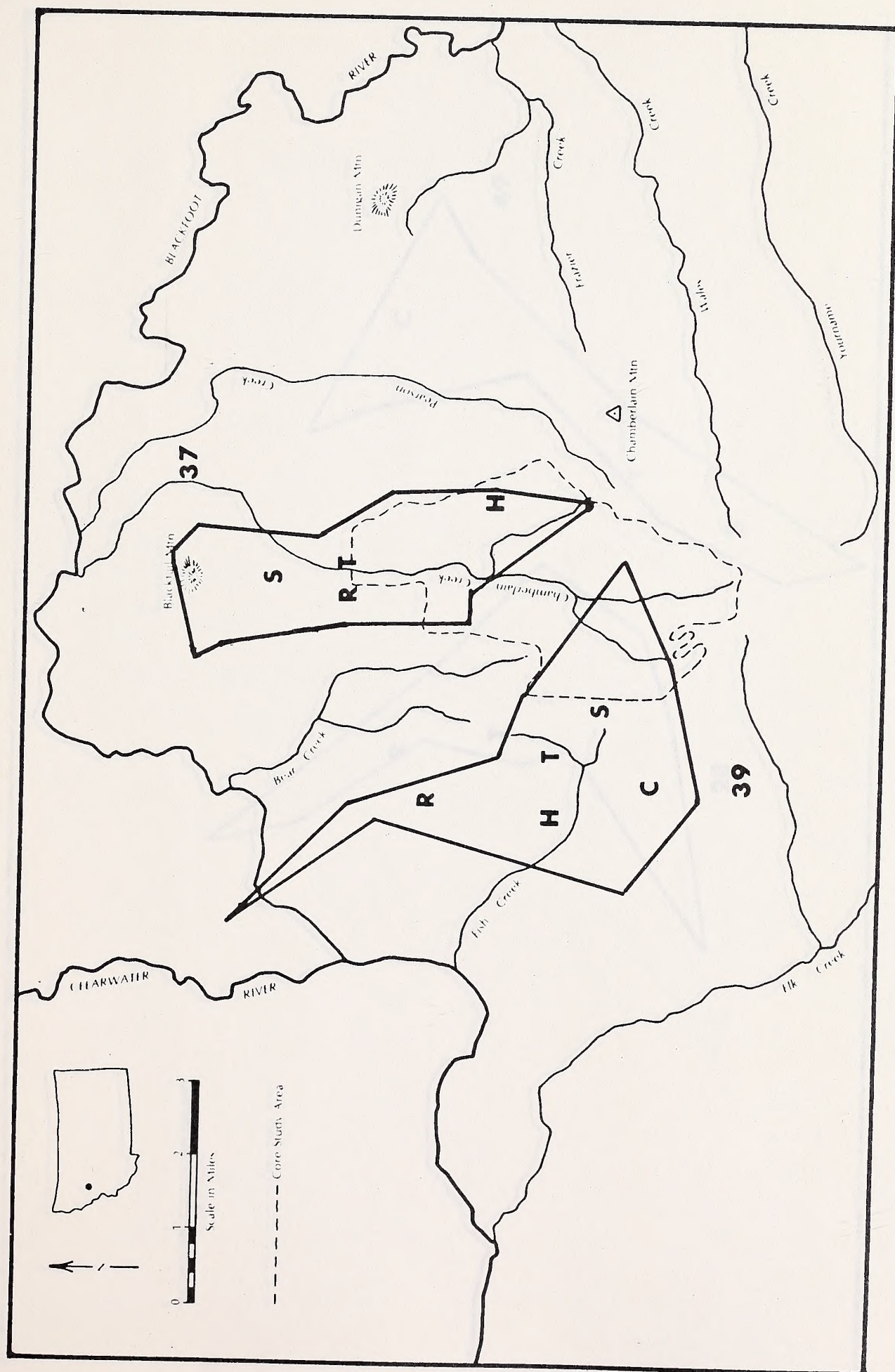


Figure 18. Home range polygons and activity centers for female elk 37 and 39.

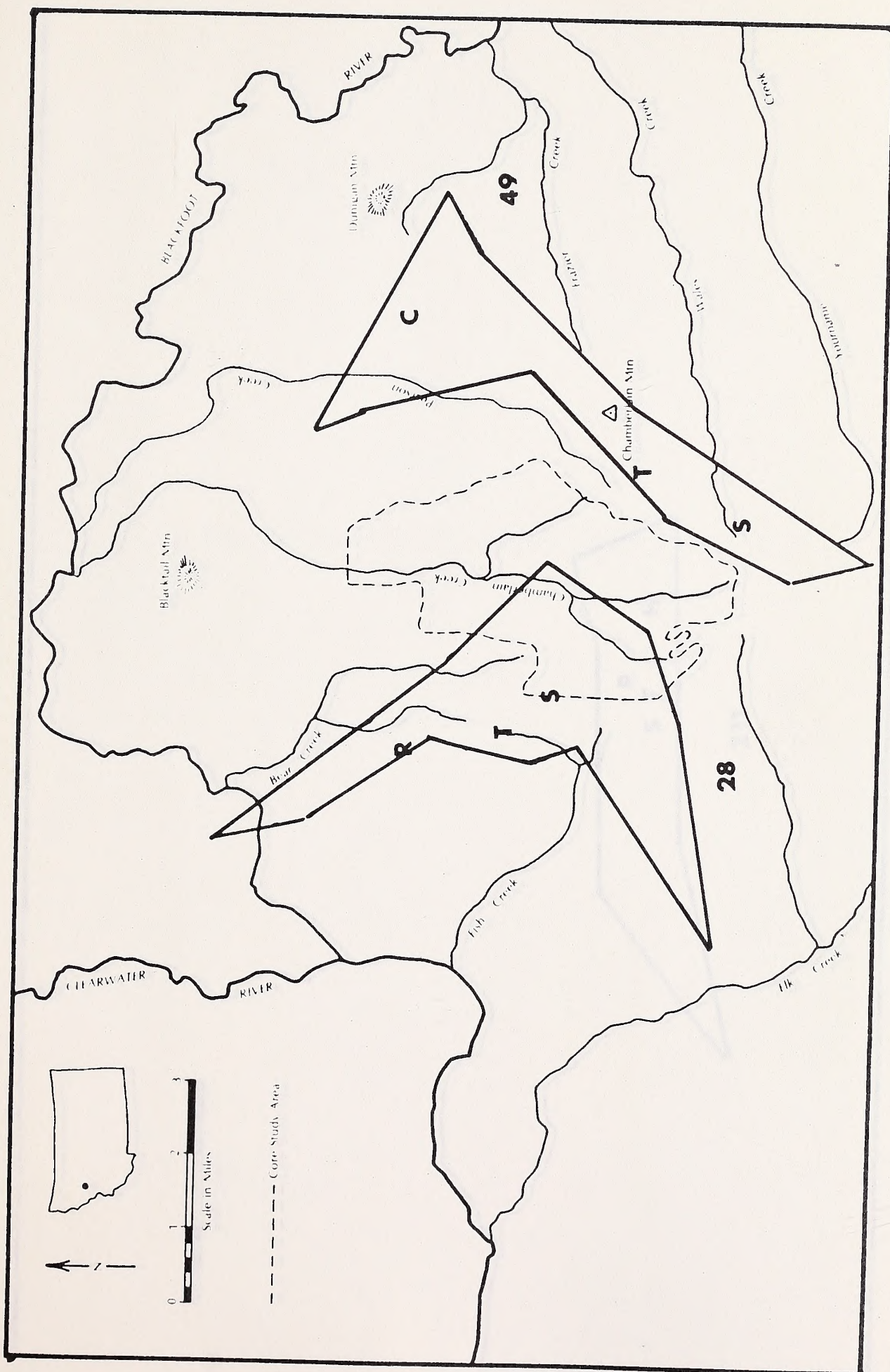


Figure 19. Home range polygons and activity centers for female elk 28 and male elk 49.

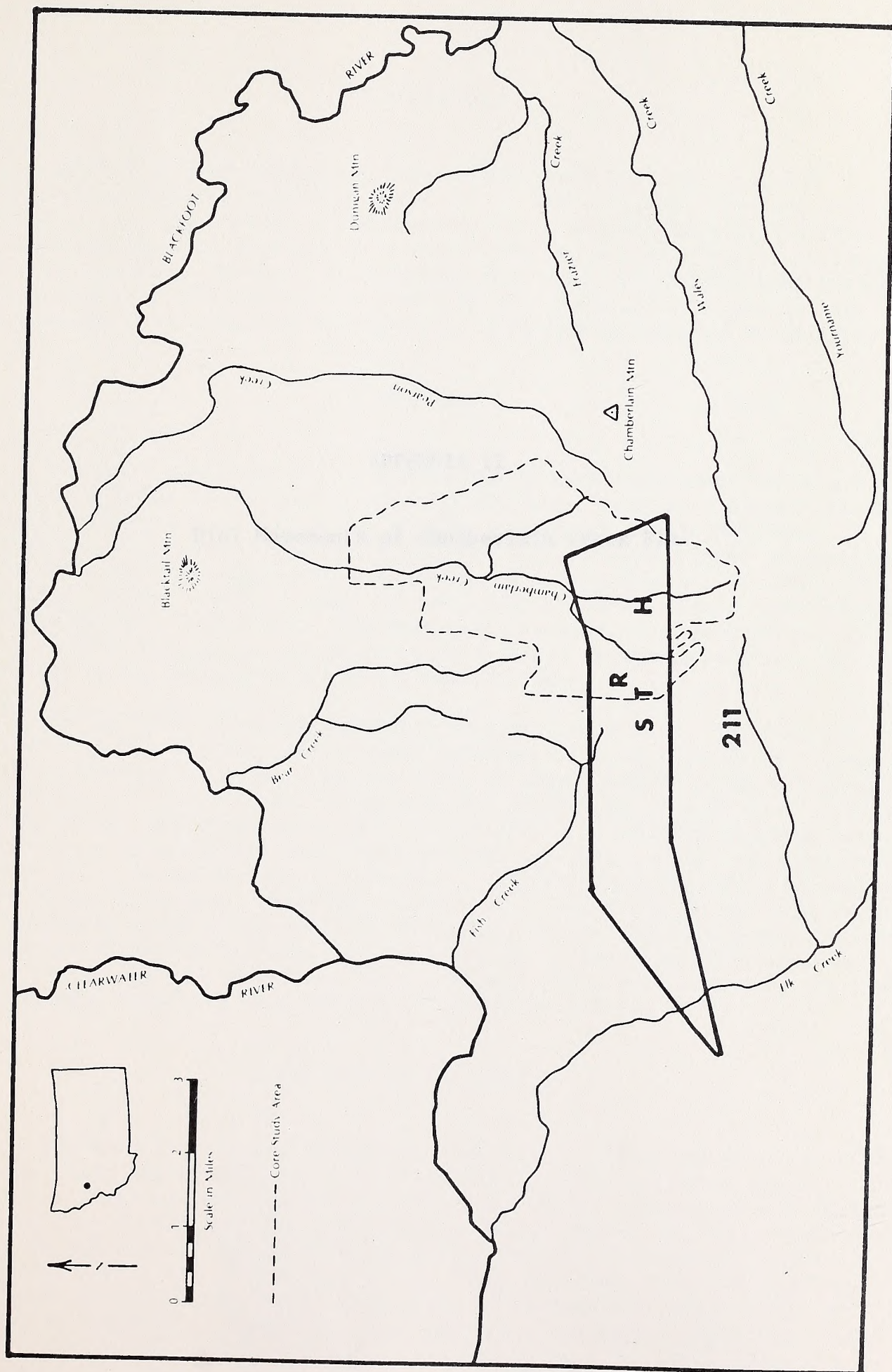


Figure 20. Home range polygon and activity centers for female elk 211.

APPENDIX II

Diel Movements of Chamberlain Creek Elk

INTRODUCTION

Radio-collared elk in the Chamberlain study area were tracked for 24-hour periods during 1978 and 1979. The original objective was to determine the immediate response of elk to active human disturbance (road-building and logging) on a finer time scale than afforded by weekly aerial tracking. However, disturbance was light and intermittent during both years, so the results are probably more indicative of elk 24-hour movements in an undisturbed situation, with similar weather conditions.

METHODS

Suitable positions for 24-hour tracking were determined after elk were located by weekly aerial tracking flights. Locations deemed suitable were: within 1.0 mile (1.6 km) of elk, preferably within 0.5 mile (0.8 km); on an open ridgetop to provide line-of-sight signal reception, and to eliminate topographic and vegetative signal bounce; and situated so that compass bearings taken on radio signals would form an approximately 90° angle of intersection. The selected locations were used throughout the 24-hour period, unless problems with signal reception were encountered. In this case, the tracking station was relocated.

During 1978, tracking equipment consisted of a radio-receiver and hand-held "H" antenna. Directional bearings on radio signals were taken with a hand-held compass. During 1979, an antenna-mast system was used to increase accuracy. An "H" antenna was mounted on an 8-12 ft (2.4-3.7 m) telescoping fiberglass pole, that was placed in a 2-tiered aluminum base. The bottom plate of the base supported the top plate, which was inscribed with 360° compass bearings. A pointer, inserted into the mast, indicated the signal direction. Bearings on all radio-tagged elk in the area were recorded at hourly intervals for 24 hours. Communication between stations, by means of walkie-talkies, enabled us to be certain that the same elk were being located at each station, and that there were no signal reception problems. Locations were later plotted in the office.

RESULTS AND DISCUSSION

Elk were located for 24-hour periods once in 1978, and 6 times in 1979. Only one day was spent tracking elk in 1978 because an assistant was not available for further tracking. Of the 6 tracking periods during 1979, only 5 sessions were successful. Table 1 shows data and statistics for 21 elk tracked during 1978 and 1979. Out of 504 possible locations for these elk, only 262 were plotted. Some locations were not plotted, because of unreliable signal reception, or because the compass bearings did not intersect. Additional locations were eliminated when they seemed

highly aberrant, that is, when they did not fit into the pattern of movements shown by previous locations. Data for eight elk were not used for one or more reasons. Too few locations were made for some; for others, the number of hours tracked was less than 20; or indicated movements were highly erratic and widely spaced in a non-realistic manner. As a result, only 187 locations for 13 elk, out of the 262 plotted locations, were analyzed.

Considerable problems were encountered in trying to successfully and reliably locate elk for the 24-hour periods. Suitable locations for tracking, as described in the methods section, were few. Most of the area is heavily forested, resulting in problems with signal bounce and attenuation. Several test situations, where bearings were taken on radio transmitters of known position, indicated an error range of -15° to $+22^{\circ}$ from the actual bearing. Constantly moving receiving locations was not deemed feasible for several reasons. Often, the point initially selected was considered the best for signal reception based on previous attempts. I felt that moving to different locations would, therefore, probably be nonproductive and difficult, in light of the limited access to desirable points. The latter difficulty may have been reduced, though, if locations were taken at longer intervals to provide more travel time. Also, it was not feasible to be constantly moving the antenna-mast system, especially at night.

As a consequence of these problems, I felt that the only reliable types of information obtainable from the elk locations were characteristics of the areas used (Table 1). Areas used were decidedly rectangular in shape. The average length was twice the average width. The former did not vary greatly between elk, but, width was twice as variable. Major differences in the width of areas used appeared to correspond to the topography of the area, which affected the ease with which elk were able to travel. Elk 211 and 28, located 9 August 1979, were tracked in the south end of the CSA. This area is for the most part gently sloping forest. The shape of the areas used for these elk was more square than those for other elk. The topography where the other elk were located is characterized by moderately steep, parallel ridges flanking Chamberlain Creek. The areas used for these elk conformed to the linear arrangement of the topography. The size of the area appeared to be also related to topography. Elk 211 and 28 used larger areas than elk in steeper country.

Table 1. Data and statistics for 24-hour movements of elk in the study area during 1978 and 1979.

Date	Elk no.	Points plotted ^a	Points used	Hours ^b	Length (miles) ^c	Width (miles) ^d	Length/width	Area (sq. miles) ^e
8-10-78	31	20	20	24	1.0	0.4	2.5	0.33
8-10-78	311	24	23	24	1.4	0.4	3.5	0.41
8-10-78	34	22	22	24	0.7	0.7	1.0	0.27
8-10-78	43	16	14	23	1.7	0.6	2.8	0.63
7-4-79	31	5	0	15	-	-	-	-
7-4-79	312	2	0	4	-	-	-	-
7-18-79	46	12	12	23	1.1	0.4	2.8	0.23
7-18-79	37	14	13	24	0.9	0.3	3.0	0.16
7-18-79	35	7	7	20	1.1	0.3	3.7	0.20
7-18-79	25	9	9	21	1.4	0.6	2.3	0.58
7-25-79	46	15	0	24	-	-	-	-
7-25-79	411	7	0	17	-	-	-	-
7-25-79	37	8	0	16	-	-	-	-
8-1-79	37	19	9	24	1.3	1.1	1.2	0.73
8-1-79	411	21	21	24	1.0	0.4	2.5	0.29
8-9-79	211	12	12	24	1.3	1.0	1.3	0.81
8-9-79	28	22	22	24	1.3	1.2	1.1	0.88
8-9-79	33	7	0	15	-	-	-	-
8-9-79	31	2	0	10	-	-	-	-
8-9-79	39	5	0	13	-	-	-	-
8-25-79	25	13	12	20	1.0	0.2	5.0	0.18
\bar{x}					1.2	0.6	2.5	0.44
Standard Deviation					0.26	0.33	1.17	0.255
Coefficient of Variation					22%	55%	47%	58%

^aNumber of points plotted out of 24 possible locations.

^bHours between first and last location.

^cMaximum length of area used (1 mile = 1.6 km).

^dMaximum width of area used (1 mile = 1.6 km).

^eArea used in square miles determined by minimum area method (1 mile² = 2.6 km²).

